FEBRUARY 1958

Power Engineering

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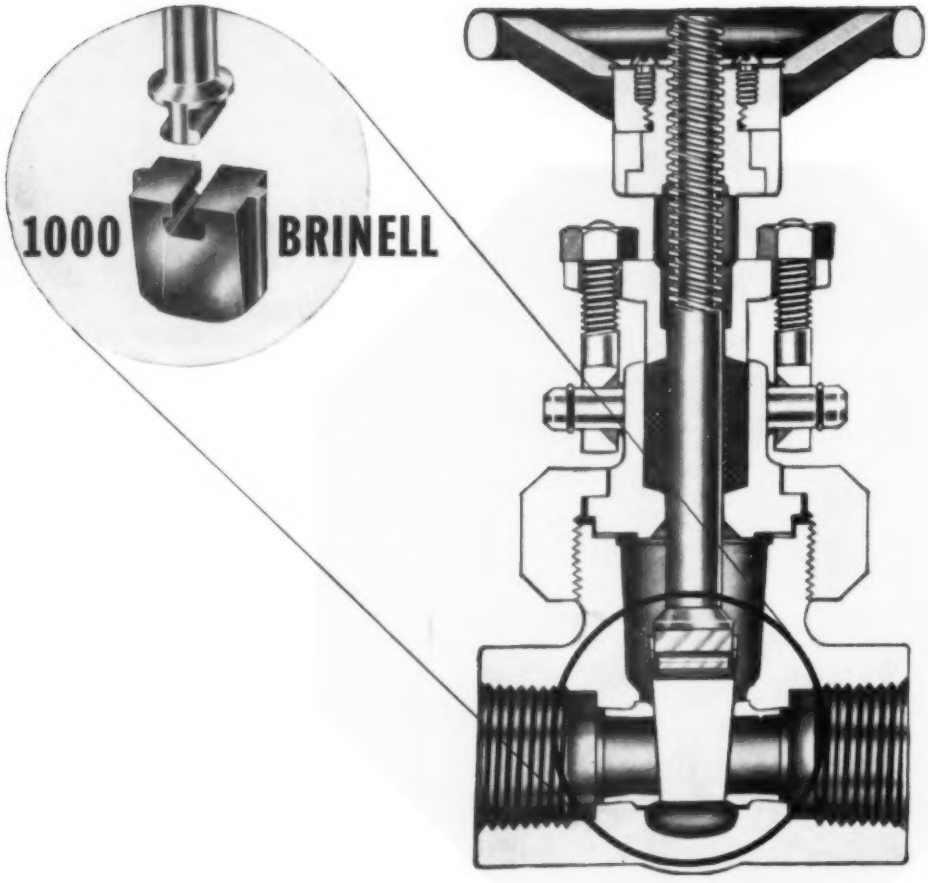

Fig. 1221

Stop Galling with the hardest valve wedges you can buy

OIC VALVES

FORGED & CAST STEEL,
BRONZE & IRON,
LUBRICATED PLUG VALVES

Highly resistant to erosion and corrosion

Here's a wedge as hard as flint . . . so hard that it's undamaged by pipe cuttings, scale or grit. It's the only trim we know of which will successfully withstand the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling. This wedge is *13% chrome stainless steel hardened up to 1000 Brinell.*

Specify the OIC 1221 gate or 1621 globe where you need the extra rugged nature of forged steel. They are recommended for steam service up to 800°F...oil service up to 1000°F. Or, use these same valves for hydraulic service up to 2000 lbs.

Write for Form 195 for specifications on the OIC forged steel line.

THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO

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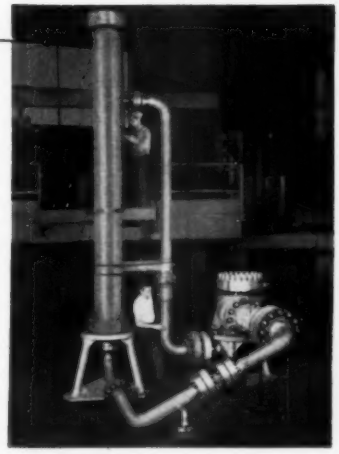
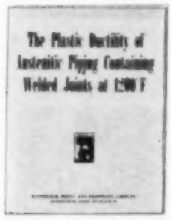
ALL IN A DAY'S WORK at Pittsburgh Piping



STAINLESS STEEL AUTOCLAVE and VOLUTE
Shop Fabricated

by Pittsburgh Piping

This autoclave and volute assembly is typical of the work that goes through Pittsburgh Piping shops. Fabricated of Type 304 Stainless Steel, it is complex in design and is built for high pressure, high temperature service. This type of fabricating is a "natural" for Pittsburgh Piping. We pioneered the application of austenitic steel piping materials for central stations operating at 1050°F. and above, and fabricated the piping for the world's first atomic-powered submarine and central station. Highly specialized methods, machines, and apparatus have been developed and are employed in this work. Use them on your high temperature, high pressure piping jobs.



WRITE FOR YOUR COPY

This bulletin reports an intensive investigation into the problem of main steam piping materials and gives data on the stress rupture characteristics of Types 316 and 347 stainless steel piping adjacent to welded joints.

Promoting Progress ***IN POWER AND PROCESS PIPING***

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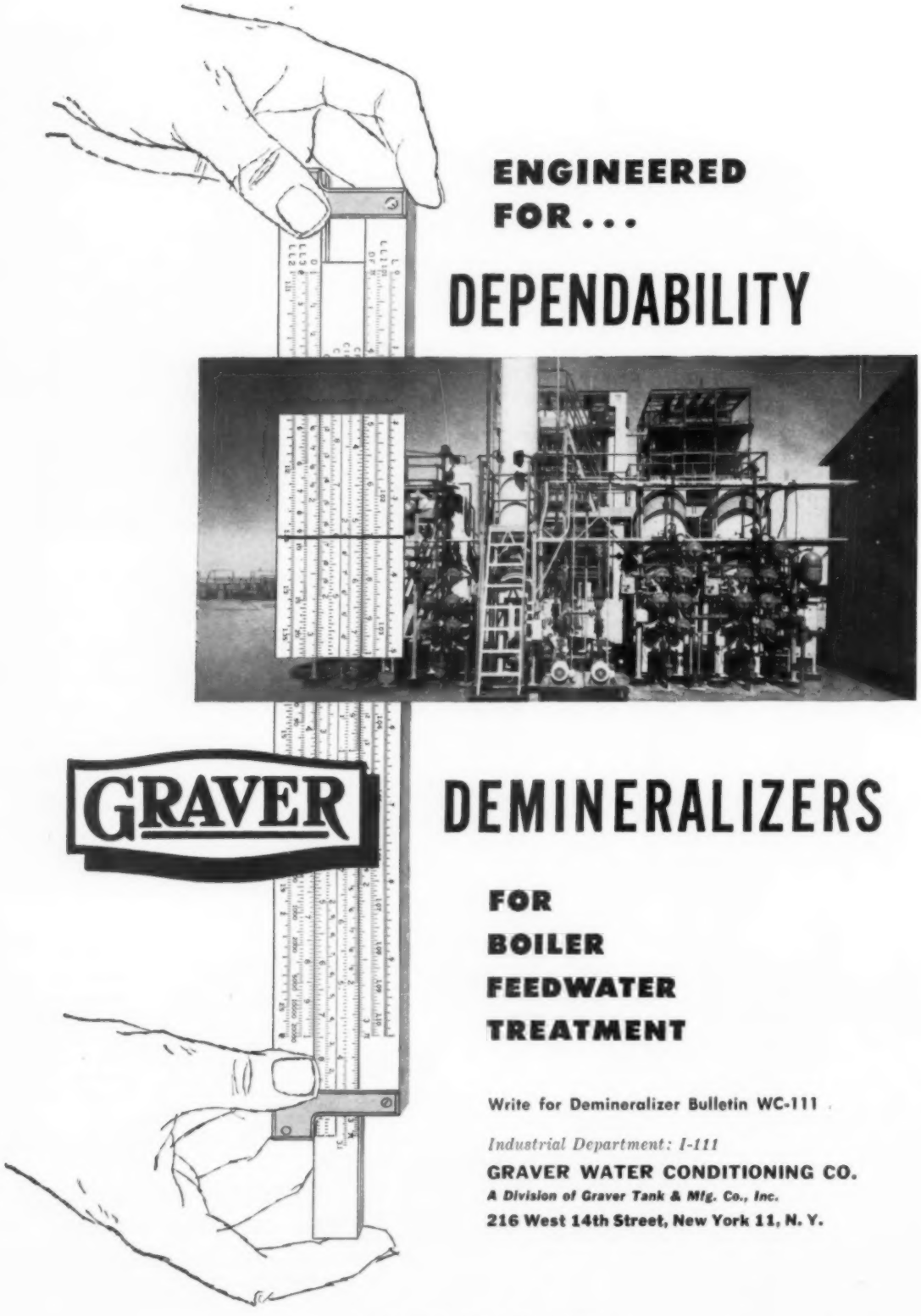

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FOR . . .

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

VALVES BY THE HUNDREDS: — How many valves are you familiar with; how many *basic* types are there; what type of valve do you use in each specific application? These questions, and many more, arise from contacts with our readers; and we hear of new valve developments almost every week, but feel sure that all power engineers don't have time to read up on all of them.

So — we have decided to run a series of articles on VALVES, as a good source of information for the younger men — and a refresher course for the old-timers. These VALVE articles will start in the next issue of POWER ENGINEERING, and will continue for several months. All will be written by recognized authorities, and each article will cover one basic type of valve. We believe this series will be of great interest to all our readers, because VALVES are certainly a "common denominator" of power engineering.

Watch for the first article, in next month's POWER ENGINEERING.

PERSONALS: Clark A. Dunn, administrative head of the School of General Engineering at Oklahoma State University, has been nominated for the office of president of the National Society of Professional Engineers.

J. W. Woomer of Pittsburgh has been nominated as 1959 president-elect of the Society of Mining Engineers. The SME election takes place this month.

Dr. John F. Thompson, chairman of the board of the International Nickel Co of Canada is the 1958 recipient of the Charles F. Rand Memorial Medal of the American Institute of Mining, Metallurgical and Petroleum Engineers. J. Roy Gordon of the same company gets the same Institute's James Douglas Gold Medal.

Louis R. Howson, member of a Chicago engineering consulting firm, is ASCE's newly-elected president.

John K. Hodnette of Pittsburgh, vice president and general manager and a member of the board of directors of Westinghouse, has been awarded the 1957 Edison Medal by AIEE "for his significant contributions . . . through creative design and development of transformer apparatus which marked new advances in protection, performance and service; his vision, judgment and management skill which fostered and achieved the practical application of his ideas with resulting advancements in the electrical industry."

Promotions have been given these three men at Bituminous Coal Research, Inc: Dr. Harold J. Rose of Pittsburgh will become vice-president and consultant; J. R. Garvey of Columbus, Ohio, will become director of research; John W. Igoe of Pittsburgh, director of administration.

ON THE HORIZON of the years just ahead, a number of power plant projects loom up impressively. Among these:

A mammoth, $30,000,000 steam electric generating unit will be installed by Duquesne Light Co at its Elrama power station in western Pennsylvania, will begin operation in the winter of 1959–60. A Babcock & Wilcox boiler will supply 1,300,000 lb of steam per hr (continuous output) at 2150 psi, 1000 F, to a 172,000-kw turbine generator. Five pulverizers will burn about 75 tons of coal hourly.

A $25,000,000 plant is planned by California Electric Power Co for a location near Daggett, Calif. The first unit is scheduled for commercial operation in the summer of 1960. Plant will have two 60,000-kw reheat turbine-generator units, each with a 475,000 lb per hr steam generator. Fluor Corp will engineer and construct the plant.

Largest turbine generator in New Hampshire will be a 100,000-kw unit scheduled by Public Service Co of New Hampshire for a new power station on the Merrimack, 15 miles north of Manchester. Westinghouse is building the turbine generator, will also supply a

condenser and electrical equipment for the station. It's a $4,000,000 order. Both units are scheduled for delivery in 1959, will boost the New Hampshire company's total power output by 30 per cent.

Although its plans for actual plant construction are not yet firm, Appalachian Electric Power Co has announced purchase of 1450 acres of land along the Ohio River at Apple Grove, W. Va. This will be the site for a future steam electric generating plant. The company is expecting further development of the Ohio River Valley by chemical and other heavy industry.

WHAT'S AMERICAN commerce and industry got to do with national strategy? The fourth national Military-Industrial Conference, to be held in Chicago February 17–19, will attempt a full-scale interpretation. Theme of the meeting is exactly this — the role of commerce and industry in U. S. national strategy. Experts are participating from defense industries, higher education, professional societies and government, from the armed forces, research centers. Among them will be: Dr. Wernher von Braun of the Army Ballistic Missiles Agency; John T. Rettaliata, president of Illinois Institute of Technology; Professor von der Heydte of the University of Wurzburg, Germany; Frederick L. Hovde, president of Purdue University; Donald Loughridge, head of nuclear power engineering of General Motors; General Maxwell D. Taylor, chief of staff, Army War College; C. Ken Weidner, dean of engineering, American University, Beirut, Lebanon.

AGAIN THIS YEAR, National Engineers' Week is being celebrated during Washington's birthday week. The dates are February 16–22, and the sponsoring body is the National Society of Professional Engineers. MIT's James R. Killian, Jr, heads the group of leading engineers sparking the week.

CORRECTION. Last month we reported here on U. S. Radium Corp's new atomic lamps called Isolites. We said that these lamps give "power-free, interrupted illumination . . ." It should have been *uninterrupted*, of course.

THIS YEAR, American Gas & Electric System expects to spend a record $190,000,000 for construction. This will be the third year in AGE's 5-year $800,000,000 expansion program. By the close of 1957, the AGE system had a total generating capability of 4,585,000 kw. It will go up to 6,365,000 kw by 1960.

INTERESTED IN GAS TURBINES? Then March 3 to 6 are your days. The place is the Shoreham Hotel in Washington, D. C., and the occasion is the annual conference of ASME's Gas Turbine Power Division.

BITUMINOUS COAL industry is establishing a major coal research center in Pittsburgh. The center will be operated by Bituminous Coal Research, and Pittsburgh industry will help support the effort. The new center represents a consolidation of the present coal-industry operated lab in Columbus, Ohio, the lab and headquarters in Pittsburgh, and the fiscal offices now in Washington, D. C.

Special Reprint Available

EVER WONDER IF you will have a place in the nuclear power plant of the future? Many power engineers have given it serious thought, but come up with the wrong answers.

For the *right* answers, write the Editor for a copy of Editorial Letter 57-3. Originally prepared for intercompany circulation only, this is an illustrated 6-page report by one of our editors who visited the Sodium Reactor Experiment, a nuclear power plant now operating in the Santa Susanna Mountains, near Los Angeles.

Designed and built by Atomics International Division of North American Aviation, Inc, and operated in conjunction with Southern California Edison, SRE provides a view of the future . . . your future.

For a free reprint copy of this illuminating report, write the Editor, POWER ENGINEERING, Barrington, Ill., or write "Letter" on the postcard elsewhere in this issue and send it to us.

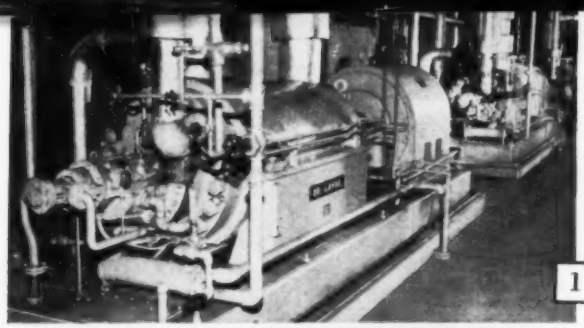
LOOKING BACK over business in '57, Westinghouse reports good acceptance for its cross-compound turbine generator. By the end of the year, nine such units, with a total capacity of 2,405,000 kw, had been delivered or were on order. An order for 13 167,000-kva waterwheel generators has been placed with Westinghouse by the New York State Power Authority. These units will be used in the Niagara Power Project. First unit scheduled for delivery in 1959.

Casting up the score for the electric industry in 1957, J. W. McAfee, president of Union Electric Co and newly elected president of Edison Electric Institute, reports a grand total of 721 billion kwh produced during the year. Industrial and railway plants accounted for 85 billion kwh. The electric industry itself produced 636 billion kwh, an increase of 35 billion over 1956.

Sales of electricity reached 561 billion kwh, an increase of 31 billion for the year. Of this total, 285 billion went to industrial customers, as compared with 277 billion in 1956.

During 1957, about 8.5 million kw of new generating capability were added to the nation's power lines, bringing the total generating capability to 135 million kw by the end of December. The coming year will see by far the largest construction program yet undertaken in the industry. Installation of new generating facilities in 1958 will exceed the previous high record of 1955 by almost 4 million kw. Over 16,000,000 kw of new generating capability are scheduled to go into service in 1958.

THE MUCH-TOUTED "shortage" of engineers got reverse publicity at the time of the annual ASME meeting in New York City late in 1957. Fourteen experienced engineers and scientists, ranging in age from 30 to 40, failing to find any demand for their services, hired a room in the conference headquarters hotel, and invited potential employers to visit them. The men had been laid off when a plant closed in New Jersey. Their gesture created only "mild" interest. One employer stated that he could be "very selective" because so many are available.



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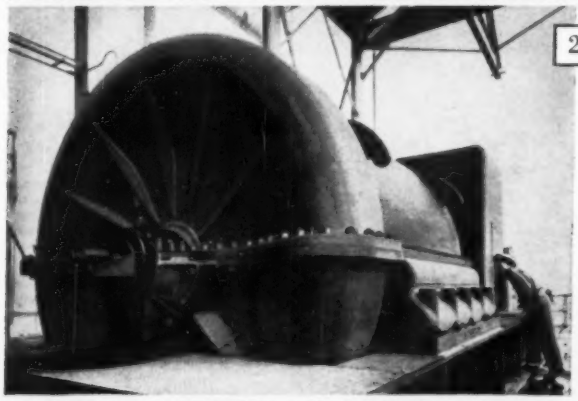

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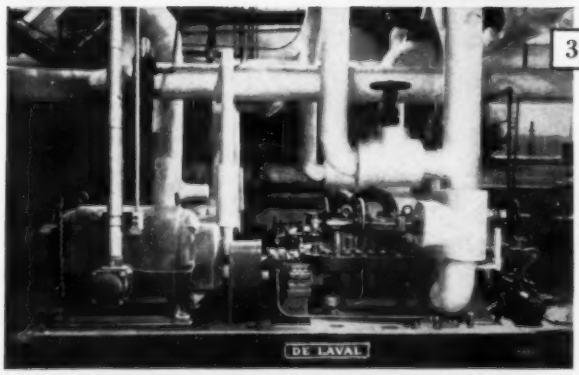

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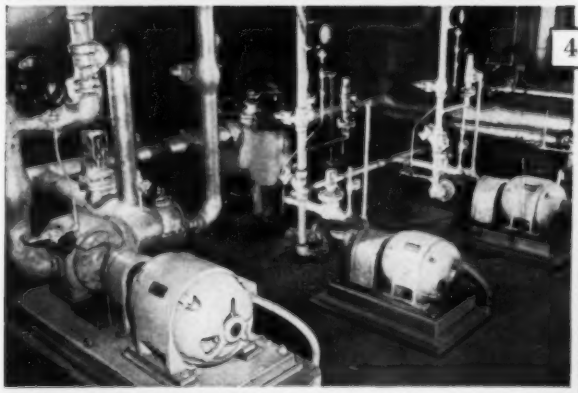

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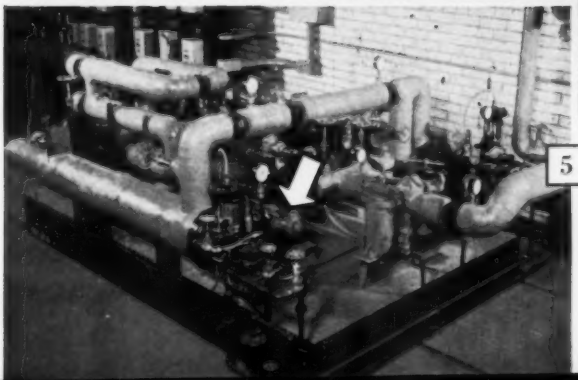

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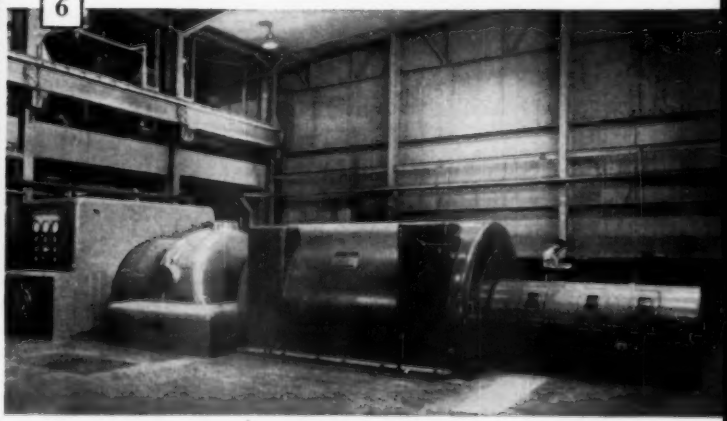
designs for dependability

Machines that *stay* in service year in and year out are the most economical. Since 1901, De Laval has supplied quality-designed pumps, compressors, and other vital equipment for industry. Each unit is designed for dependability and built by master craftsmen. As a result, the De Laval name plate is your assurance of reliability. Literature is available on all equipment shown on these pages.

1. Barrel type boiler feed pumps
2. Centrifugal compressors
3. Centrifugal pumps for many services
4. De Laval IMO pumps for fuel oil transfer
5. De Laval IMO pumps for fuel oil burner service
6. Multi-stage turbine generators



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DE LAVAL

Steam Turbine Company

816 Nottingham Way, Trenton 2, New Jersey

DL-401

WHAT THEY TELL US

▶ **SEPTEMBER'S STILL WITH US,** in our correspondence about POWER ENGINEERING articles, that is. The issue for that month in 1957 seems to have been of unusual help to an unusually wide range of readers. As late as November we were still getting requests for tear sheets of September articles. From Washington, D. C., Glynn L. Coryell, engineering consultant, wrote for copies of three of those articles, and commented:

> This September issue had some unusually good articles, for which your staff should be complimented. Mr. Setterlund has done an excellent job in his article (Old Steam Plant — New Broom) by including some real "meat" for the operator.

▶ **HELP FOR THE NAVY** came out of a recent exchange of letters we've had with H. O. Bishop of the District Public Works Office, 11th Naval District, in San Diego, Calif. Bishop's eye had been caught by How To Inspect Power Transformers, in the June, 1957 issue of POWER ENGINEERING. He asked for tear sheets, which we sent. Finale:

> Thank you for your assistance in furnishing 50 tear sheets of page 110 from the June, 1957 issue. These sheets were included in brochures prepared for use at Preventive Maintenance Workshops to be conducted throughout the 11th Naval District during 1957–58. The data contained in these inspection instructions are very appropriate and most helpful.

▶ **BOILER TUBE CLEANING** is a problem which has stimulated J. Fallon, operating manager of a Chicago shopping center, to ask:

> Are there any simple mechanical means for cleaning the tubes of hrt boilers? I "punched" tubes years ago as a kid, but with today's cost of labor, someone must have made a mechanical soot cleaner for low-pressure hrt boilers.
>
> Of course, my men have been using industrial-type vacuum cleaners for a good many years, but I do think it is about time something new came on the scene.

We heartily concur with Mr. Fallon's sentiments. Anybody know of anything new to suggest?

Some years ago, a mechanical soot blower for hrt boilers was manufactured and was described in POWER ENGINEERING. This device was designed to be installed on existing boilers. But we don't know whether or not it is still being marketed. We'll find out for you.

▶ **ANOTHER SEPTEMBER ISSUE** correspondent is L. P. Bagby, power superintendent of Electro Metallurgical Co. Bagby writes us:

> In your September, 1957 issue an article titled Old Steam Plant — New Broom stated: "Coal samples indicated 90–95 per cent through 200 mesh screen. All classifier dampers were set to agree with external indications and fineness was reduced to approximately 75 per cent through 200 mesh."
>
> My question is, how does this improve boiler efficiency or contribute to higher load?

We've sent Bagby data on the two principal reasons why, but would like further comment from readers. What would you say, in addition to (1) the 75 per cent fineness requires much less pulverizer power, and (2) the 75 per cent value is fine enough to produce best combustion in the furnace? That value of 75 per cent seems to be accepted as satisfactory by most of the pulverized-coal-fired plants we know about.

▶ **MECHANICAL COAL SAMPLING** was discussed in a POWER ENGINEERING article in August, 1957, by G. W. Stevens. R. L. Coryell, division engineer for ConEd in New York, now sends this warning in connection with mechanical sampling:

> The conclusion is implied that such sampling is accurate and desirable. We would like to direct your attention to a large amount of data obtained in recent years that leads to one definite conclusion; namely, a mechanical coal sampler cannot be considered reliable until properly designed tests have been made and it has been shown to be free of bias.
>
> Extensive tests were made on both the spoon and screw conveyor types of samplers, and the results reported at the 1954 ASTM Symposium on Coal Sampling. Having developed the screw-type sampler here at Con Edison, we are naturally familiar with the tests involved and the accuracy obtained, as reported in ASTM STP-162 (1954). In developing that sampler and in testing several others we always expect to find bias, and usually do. Modifying the sampling points, handling equipment, etc., must be done until the bias is removed.
>
> In Table II of your article there is a good example of the fallacy of comparing analyses of samples taken by two methods. How do we know which method, if any, is correct? If the hand sampling method (2) is right, then there is an ash value bias of 0.67 per cent. As outlined in the above papers, there is a positive method for ascertaining the accuracy of any sampling method. We believe your readers should be warned that just installing a mechanical sampler will not automatically insure the collection of representative samples of coal.

Coryell goes on to say that this does not imply that ConEd is not sold on the use of mechanical sampling. He believes that ConEd installed the first one in the U. S., sometime prior to 1935.

▶ **GARAY REPRINT** requests are piling up. Reader E. F. Bridler's comments are typical of many other readers:

> I find the articles titled Train Your Operators Right for Your New Industrial Power Plant very interesting. I would like to save these articles for reference material and would appreciate your providing tear sheets of same.

We plan to reprint this series of five articles by Paul N. Garay, on the problems encountered in planning for operation of a new industrial power plant. Want a set for your permanent file?

▶ **RECENTLY** we polled a group of readers of POWER ENGINEERING, asked each if the copy he read was routed to others in his plant. In every case the answer was yes, to a total of readers for each copy of over five times the original number of readers questioned.

Also, they told us that maintenance, labor, training and training programs constitute the area of their activities which gives them the most concern, with maintenance most important.

The better we know and understand our readers, the better we can serve them editorially. The columns of this department are one important way of advancing this cause. Write us any time, about any problem or any professional interest that may be on your mind.

Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

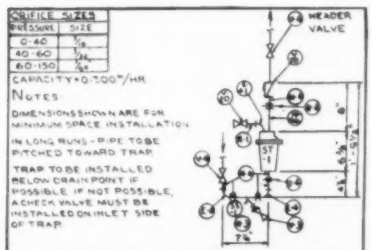

ORIFICE SIZES
PRESSURE | SIZE
0-60 | 3/16
40-60 | 1/4
60-150 | 5/16
CAPACITY=0-300#/HR
NOTES
DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP
HEADER VALVE
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK | REQD | MAT'L | DESCRIPTION
ST-1 | 1 | STEEL | 3/4" STEAM TRAP - ARMSTRONG #211
SS-1 | 1 | STEEL | 3/4" STRAINER - 250# W.S.P. -
V-4 | 2 | BRZ | 3/4" GATE VALVE - SCRD - 300# W.S.P. -
V-20 | 1 | BRZ | 3/4" GLOBE VALVE - SCRD - 200# W.S.P.
V-1 | 1 | BRZ | 3/4" GATE VALVE - SCRD - 200# W.S.P. -
V-70 | 1 | BRZ | 3/4" CHECK VALVE - SCRD - 200# W.S.P. -
E-4 | 2 | F&SS | 3/4" SCRD ELL - 2000#
E-41 | 1 | F&SS | 3/4" - 90° STREET ELL - 3000# -
U-4 | 2 | F&SS | 3/4" UNION - 2000#
N-1 | 1 | STL | 3/4" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 | 1 | STL | 3/4" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 | 6 | STL | 3/4" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4/4 | 1 | STL | 3/4" - 4 LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53

Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8102 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

For more data circle 505 on Post Card

now fully

YARWAY REMOTE BOILER

With the addition of the new pressure compensator described on opposite page, full-scale accuracy of water level indication is provided not only at "working pressure" but *also at all other boiler pressures.*

The Yarway Remote Indicator now offers *completely accurate readings of the boiler water level under every operating condition.*

For complete information on Yarway Indicators and pressure-temperature compensation, write for Bulletin WG-1814 and new compensator supplement.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NOTE: Ask about the application of Yarway Indicators for 900 psi and higher pressures under Boiler Code Case 1155 (two indicators in place of one of the two required gage glasses).

YARWAY®

...a good way

compensated *

WATER LEVEL INDICATORS

ADVANTAGES OF YARWAY PRESSURE COMPENSATOR

1. Compensating mechanism is applied to the Yarway indicator without change in internal construction of the indicator.

2. Well-known dependability of bourdon tube insures reliability and long life.

3. Trouble-free operation because linkage is simple and direct.

4. For maximum sensitivity, the indicator pointer is mounted on jewel bearings.

5. Rugged shock-resistant mounting carries weight of compensator mechanism without burdening the pointer mechanism.

6. Boiler conditions are readily simulated for check of instrument calibration at operating pressures, with remainder of indicator system under atmospheric pressure.

7. Application of pressure-temperature compensation for density changes in boiler water insures desired accuracy of level indication at all operating pressures and at all points on the pointer scale.

**Pressure compensator available on request, at extra cost.*

Model showing mechanism of Yarway Pressure Compensator. Placed between Indicator operating and indicating elements, the compensator mechanism corrects the level indication by changing pointer travel to compensate for variation in water density due to changes in boiler pressure.

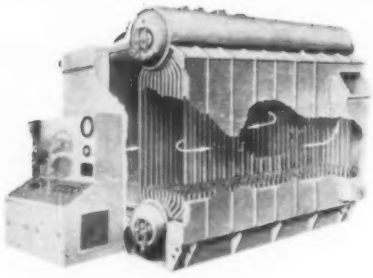
(Not shown) Yarway Remote HI-Lo Alarm Signals (lights and/or horns), operated by the Indicator. May be placed at any location in the plant.

(Not shown) Yarway Electronic Secondary Indicator to provide duplicate reading at any other location. Same size and appearance as primary indicator.

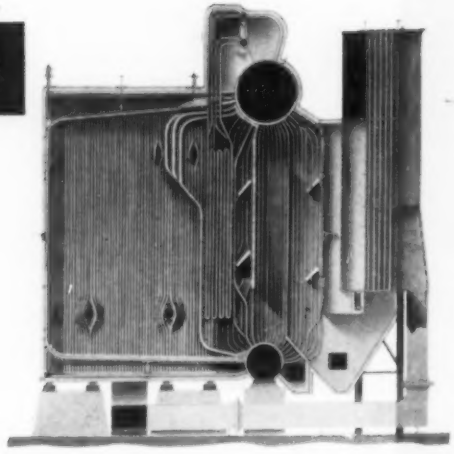
to specify remote liquid level indicators

For more data circle 506 on Post Card

OIL AND GAS FIRED BOILERS
(standardized designs)



C-E Package Boiler, Type VP – Completely shop assembled . . . available in 14 sizes from 4,000 to 50,000 lb of steam per hr capacity . . . pressures to 500 psi. Available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type.



C-E Vertical-Unit Boiler, Type VU-55 – Available in six sizes . . . capacities from 50,000 to 120,000 lb of steam per hour . . . designed for two pressure ranges, 250 psi and 500 psi, and total steam temperatures up to 750 F. Equipped with tangential burners. 60-inch steam drum assures generous water capacity and steam reservoir space. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.

MODERN INDUSTRIAL

C-E offers the most advanced steam generating in any size . . . for any fuel . . . with any method

All the designs pictured here have something in common. All are evolved from a basic design concept – a 2-drum, vertical boiler with fully water-cooled furnace in front of the boiler proper – a design which Combustion Engineering originated more than 30 years ago and which has enjoyed the widest acceptance.

All are fully integrated designs comprising boiler, furnace, fuel-burning and, where required, superheat and heat-recovery equipment, coordinated into a smoothly functioning unit.

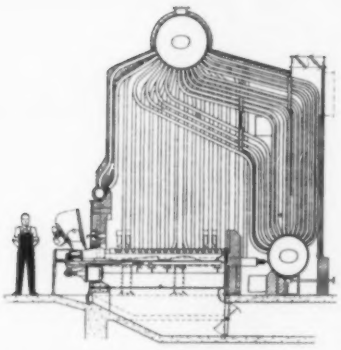
All have benefited from C-E's experience in meeting the most exacting standards in steam generation – those of the electric utility industry for which C-E is currently designing and building boilers which will set tomorrow's standards of capacity, pressure and temperature.

All have demonstrated – in many installations – high standards of performance . . . economy, reliability and suitability for the particular fuel and operating conditions for which they were selected.

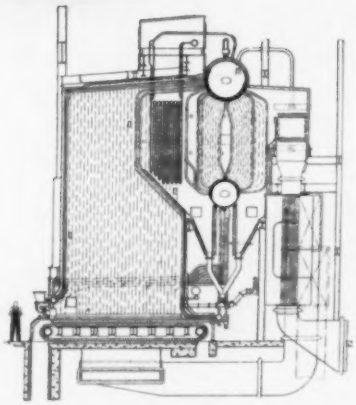
So – no matter what combination of conditions prevail at your plant, Combustion has a boiler unit that can meet your requirement, exactly – and economically. We'd like to discuss it with you and your consultants.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

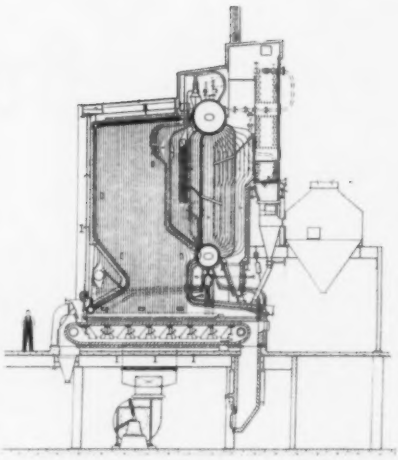
STOKER-FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-10 — fired by a C-E Underfeed Stoker, Type E — VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr with pressures to 475 psi; superheat to 200 F in larger sizes. Also can be equipped with C-E Spreader Stokers, dump grate type.



C-E Vertical-Unit Boiler, Type VU-40 — fired by C-E Spreader Stoker, continuous discharge type — A baffleless boiler with capacities ranging up to about 300,000 lb of steam per hr, with pressures to 1,200 psi; temperatures to 950 F.

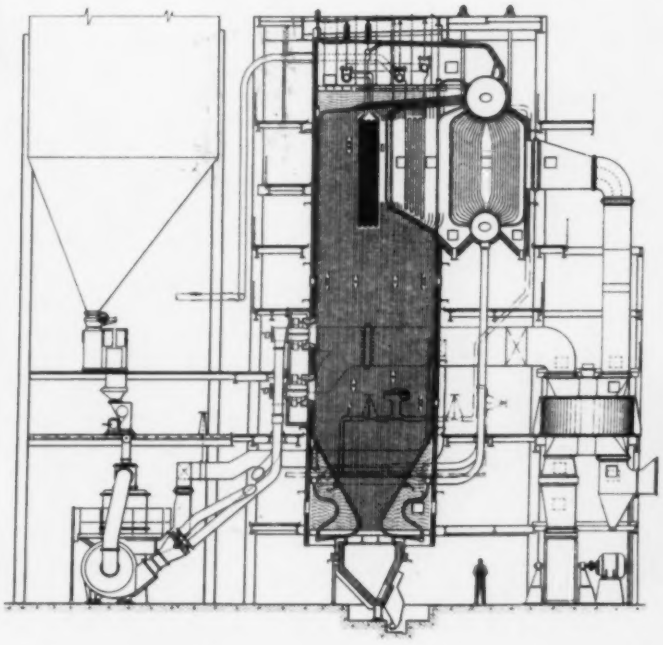


C-E Vertical-Unit Boiler, Type VU-50 — fired by C-E Traveling Grate Stoker — Units of this design are suitable for capacities up to about 150,000 lb of steam per hr; pressures to 1,200 psi; temperatures to 950 F.

BOILERS

equipment of firing

PULVERIZED COAL FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-40 — using C-E Raymond Bowl Mills and Horizontal Burners — Capacities up to 600,000 lb of steam per hr, pressures to 1,200 psi, temperatures to 950 F.

These drawings are a few examples of the many units available for coal firing: all are readily adaptable to oil or gas firing.

COMBUSTION ENGINEERING

C-E

C-139

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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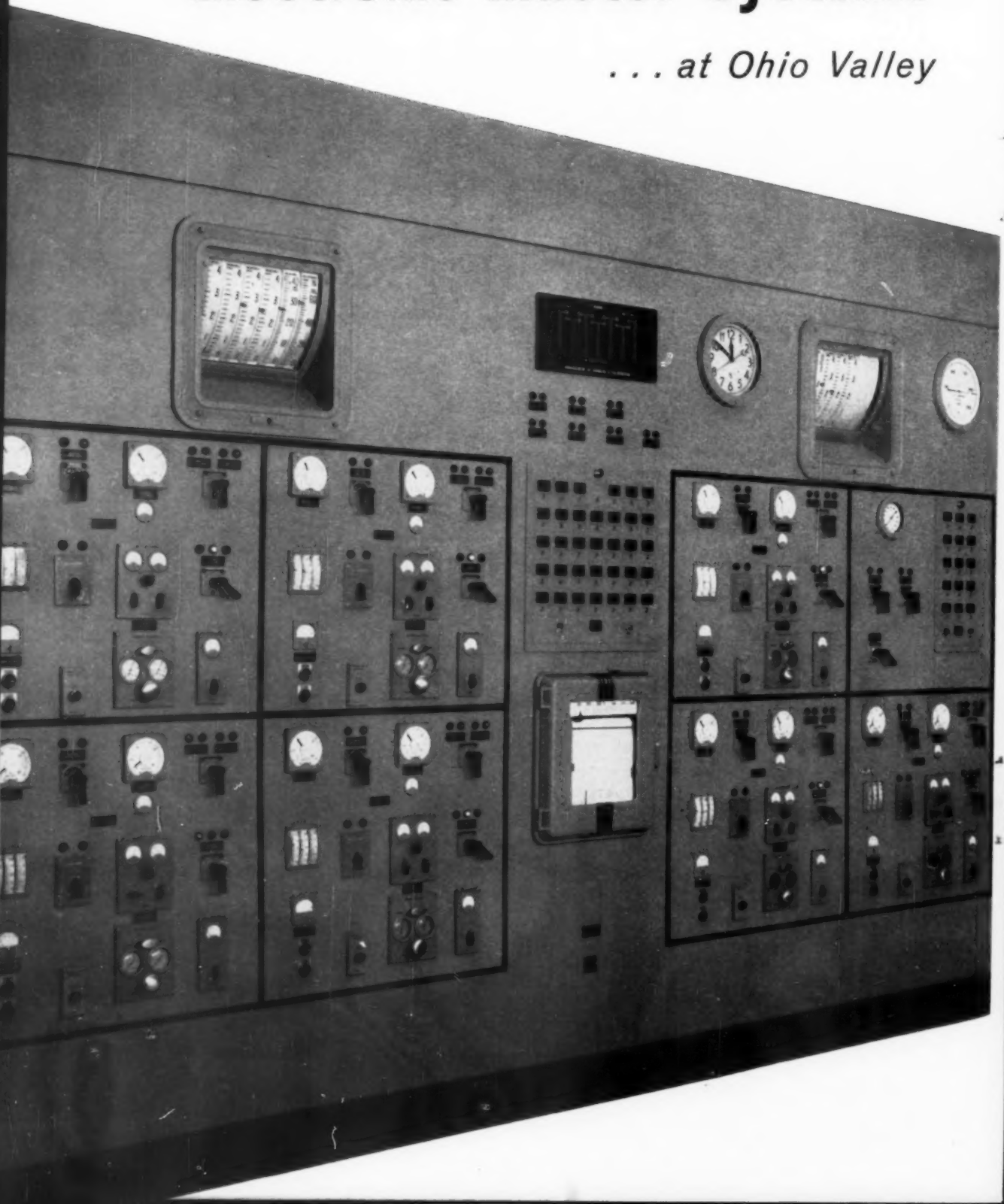
ANOTHER REPUBLIC ACHIEVEMENT!

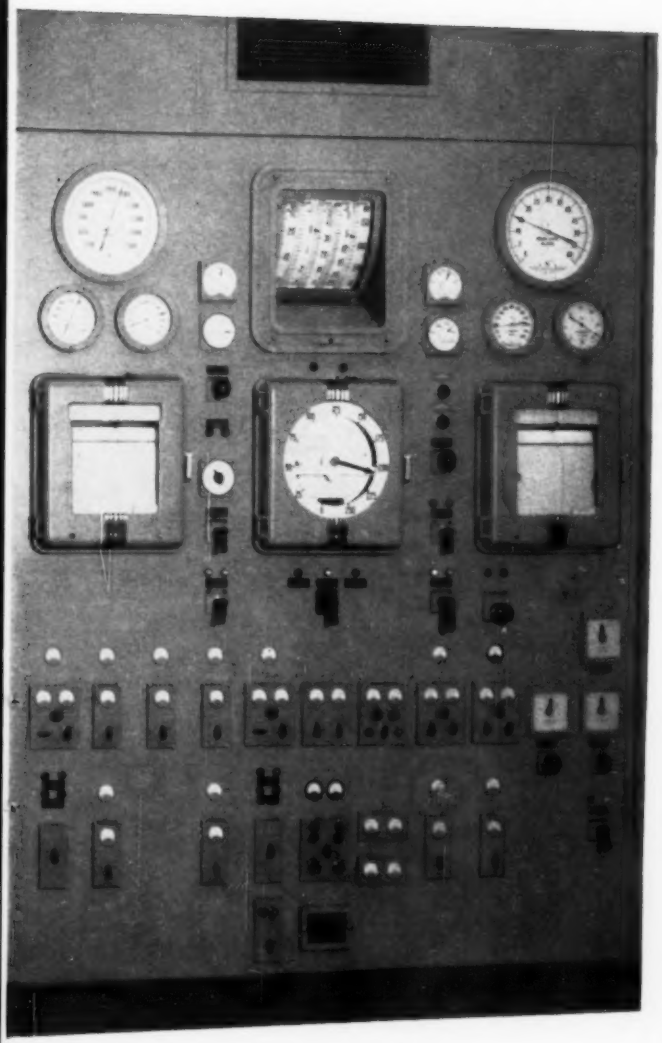
Electronic Master Systems

. . . at Ohio Valley



Control Five 1,400,000 lb/hr. Boilers

Electric Corporation's Kyger Creek Power Plant



One of Kyger Creek's five Republic control centers. An Electronic Master operates to provide electric signals for pneumatic power positioners on 7 coal pulverizers, 2 F. D. fans and 2 I. D. fans on each boiler.

Five large boilers in this plant produce a million kilowatts for our nation's atomic energy program. Multiple components on each boiler must work simultaneously as a single unit, in order to operate at maximum efficiency under all loads. A Republic *load-sensing* combustion control system with an Electronic Master regulates all these inter-related functions . . . counters every fluctuation in steam flow with corrected fuel and air flow settings without waiting for variations in steam pressure. An integral *pressure* control system makes final corrections in control signals (if necessary) to hold steam pressure constant.

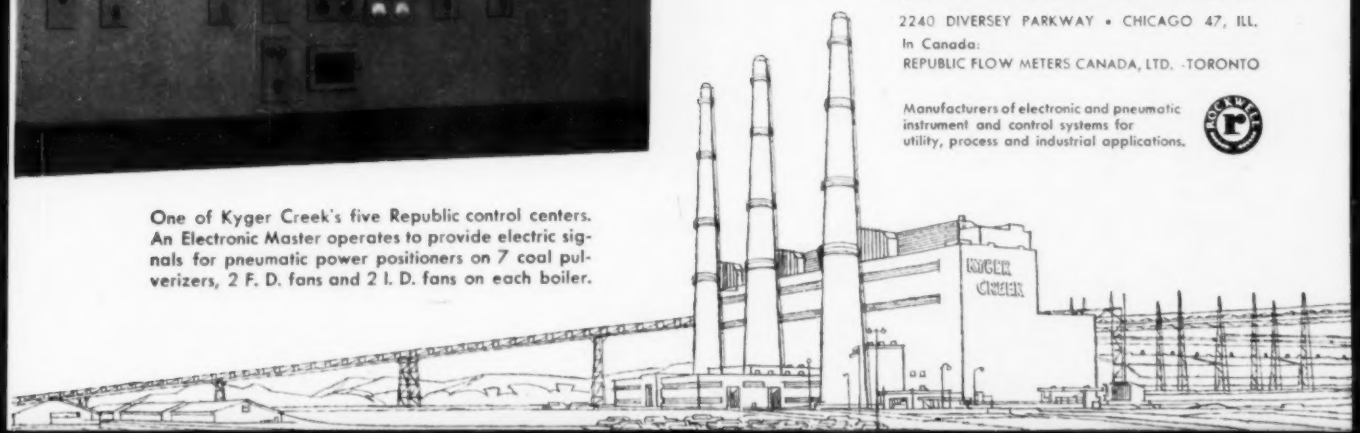
Republic's experience with plants of all sizes, all pressure and temperature ratings, and all load characteristics is your best guarantee of getting all the premium performance built into your major equipment. A technically-trained, thoroughly experienced Republic Sales Engineer is ready to discuss your instrument and control problems. Republic sales offices are located in principal cities throughout the country.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

2240 DIVERSEY PARKWAY • CHICAGO 47, ILL.
In Canada:
REPUBLIC FLOW METERS CANADA, LTD. -TORONTO

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

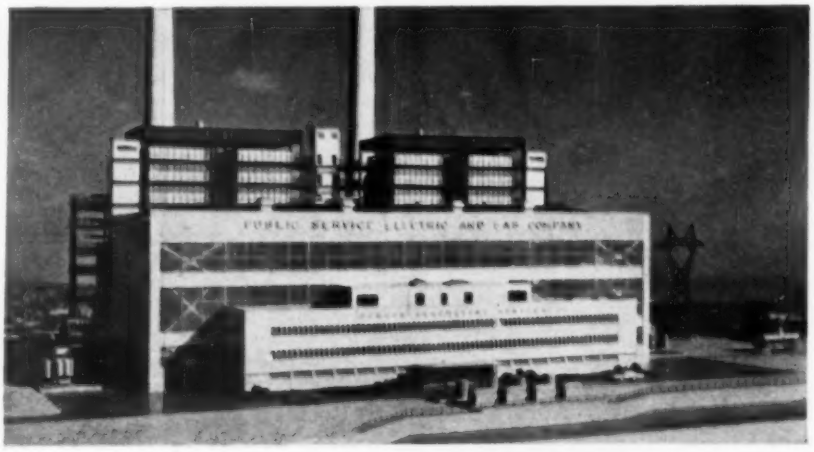


Kw Capacity GOING UP

for PUBLIC SERVICE ELECTRIC AND GAS COMPANY

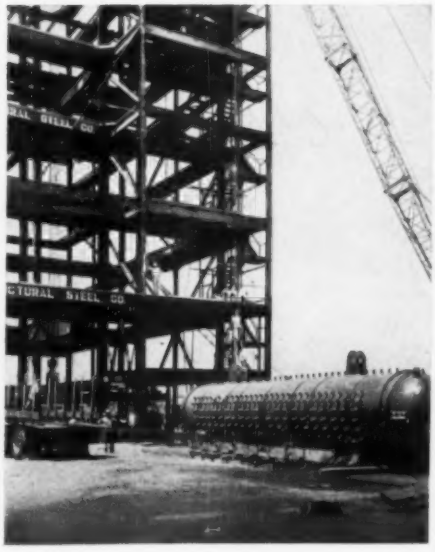
New Bergen Generating Station will add 580,000 kw to The Public Service system— and Units No. 1 and No. 2 will both be served by FW double-furnace reheat steam generators of 1,900,000 lb/hr capacity

THE GREAT postwar growth of New Jersey's industry and suburbs has placed heavy demands upon the power capacity of Public Service Electric and Gas Company. To keep ahead of this rapidly growing demand, Public Service has embarked upon a construction program which will amount to approximately $345,000,000. An important segment of this expansion program is the construction of the new Bergen Generating Station, in Ridgefield, which will have an output of 580,000 kw — increasing system capacity by 27½% over that of December 31, 1956. The station will consist of two generating units of 290,000 kw each and is scheduled for service in the early part of 1959.

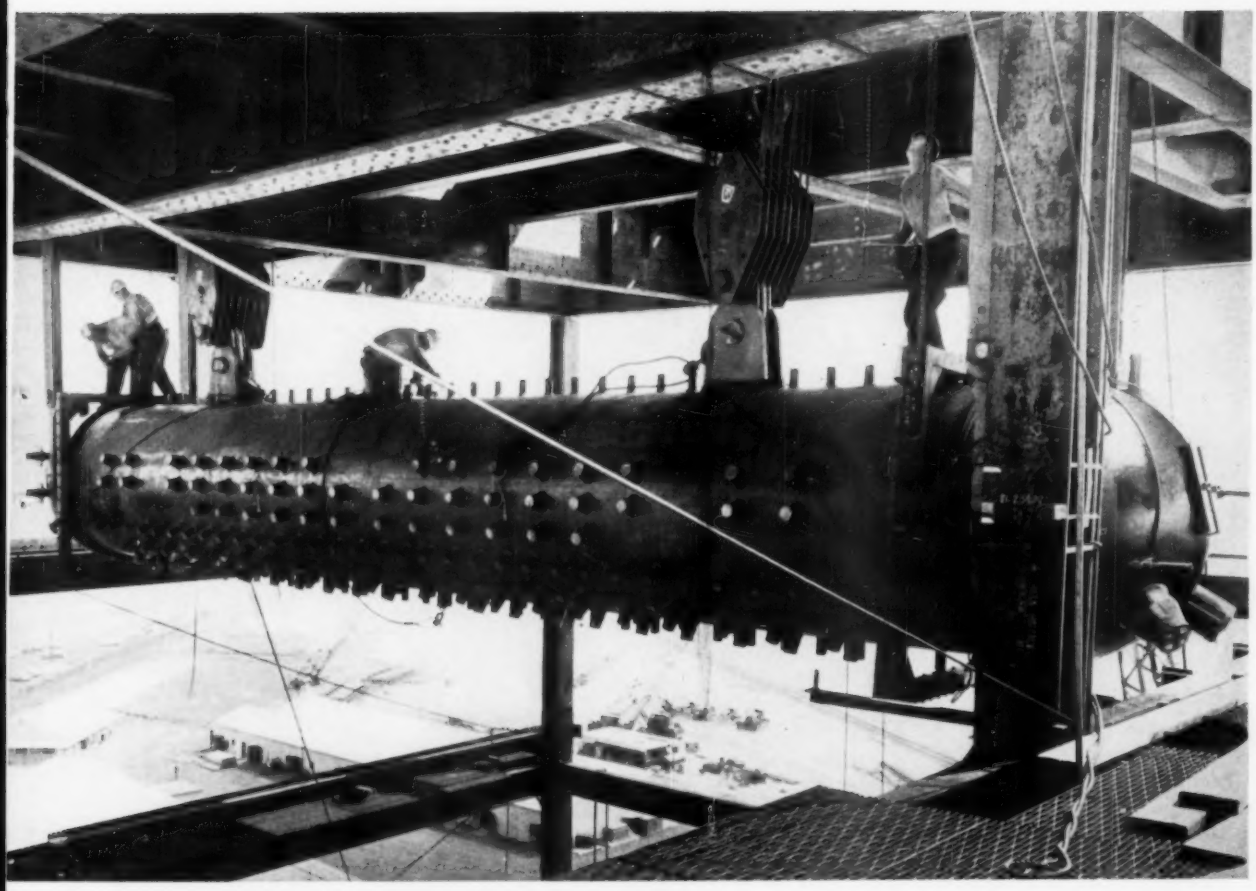


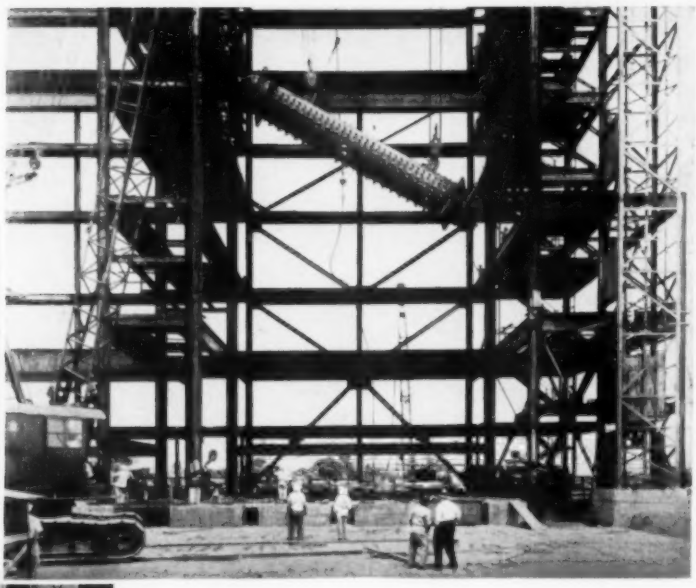
Both units at the Bergen Generating Station will be served by Foster Wheeler steam generators — each generator providing 1,900,000 lb of steam per hour at a design pressure of 2,725 psig. Primary steam temperature will be 1100 F with reheat temperature of 1050 F. The units are of double-furnace, natural circulation design and are fueled by pulverized coal. They are constructed for pressurized operation, utilizing forced draft fans only.

In addition to the steam generators Public Service has also ordered six FW ball mill pulverizers — three for each unit. With capacities of 81,000 lbs of coal per hour each, they are the largest ball mills manufactured by FW to date.



With more than a half-century of experience in steam generation — and the finest modern manufacturing facilities in three large plants—Foster Wheeler welcomes the opportunity to quote on your requirements. You'll receive the same kind of heat engineering experience and service that led Public Service Electric and Gas Company to award Foster Wheeler its part of the Bergen Generating Station.





The photographs at left and above show three stages in the process of hoisting the 125-ton steam drum into erected position in the FW steam generator for Unit No. 1 at the Bergen Generating Station of Public Service Electric and Gas Company. The generator will supply 1,900,000 lb of steam per hour at 2,725 lb/sq in gage design, 1100 F primary steam temperature and 1050 F reheat temperature.

Both of the units at Bergen are expected to go into service early in 1959.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

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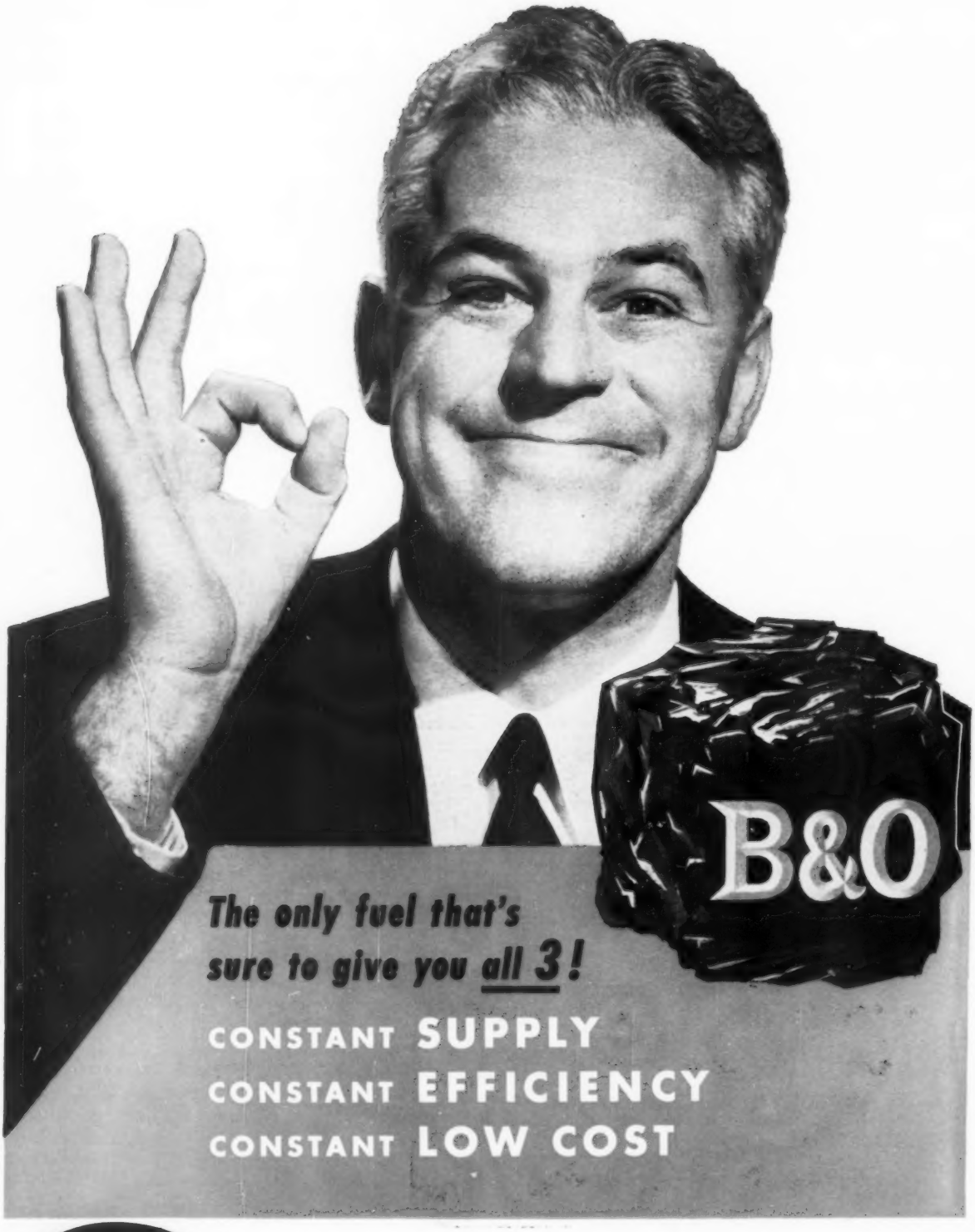

B&O BITUMINOUS COALS FOR EVERY PURPOSE

Ask our Man! BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD. *Phone* LExington 9-0400

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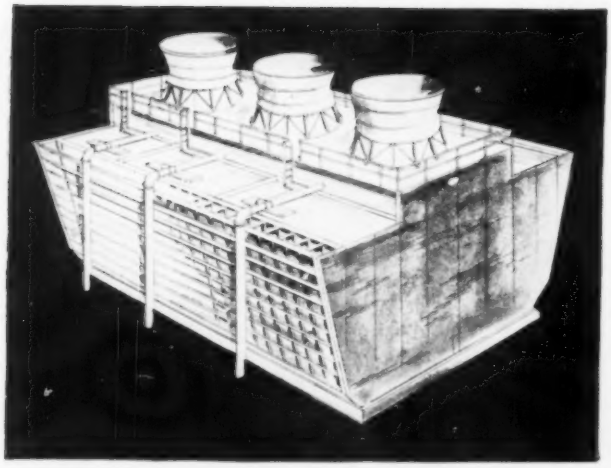
MARLEY

A new slant on Industrial Cooling Towers



MARLEY Class 600 Double-Flow

NEW IN PROFILE—NEW IN PERFORMANCE. These characteristic advances announce a forward trend in cooling towers and introduce the new Marley Class 600 Double-Flow and Single-Flow models. They embody design improvements that are seven-league strides in water cooling practice and achievement. ● ● ● The new profile is completely functional. It is the basis of many fundamental changes that mean increased cooling capacity in every frame size with greater power economy and no additional basin cost. Class 600 Cross-Flows have more filling and the ability to keep more water in the fill area; to reduce direct, unbroken water fall. The fill is of uniform width at all elevations, exposing the water to equalized air flow at all points of the cooling chamber. ● ● ● From the new wide louvered walls to the fan, air flow is cleared of obstructing elements. Pressure control and air discharge are more proficient. This lowered draft loss efficiently balances increased water capacity in Class 600 Cross-Flows. ● ● ● The angled louver walls make possible simple controls that facilitate winter operation in areas where icing is a problem. ● ● ● In Class 600 Cross-Flows extended durability—increased resistance to corrosion—keeps pace with stepped-up cooling ability. They are the first standard models completely asbestos cement board encased, and they introduce inert materials for use throughout the structure. ● ● ● These towers establish a quality standard new to water cooling equipment and of importance to you as an investor. You can get all detailed information from the nearest Marley engineer in 56 major cities or by writing direct.

The Marley Company

Kansas City, Missouri

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Announcing

another outstanding development soon to be available by the makers of BUSS FUSES

FUSETRON

LOW-PEAK

FUSES

Have

CURRENT LIMITING

added to

High Interrupting Capacity

and

Long Time-Lag

Made in all standard sizes above 60 amperes

FUSETRON Low-Peak Fuses are made in all standard sizes above 60 amperes—both 250 and 600 volt ranges.

In 60 amperes and smaller sizes tests show that FUSETRON dual-element fuses have sufficient current limitation to protect circuit and components in all normal cases.

Now you can have a high degree of protection against the thermal and mechanical stresses that heavy fault currents often impose on switches or other circuit components.

FUSETRON Low-Peak Fuses have a current limiting element that cuts off fault current so fast that it cannot build up to a damaging peak.

These new FUSETRON Low-Peak Fuses are built on the same principle as FUSETRON dual-element Fuses. They have:

the same High Interrupting Capacity

the same Time-Lag to hold harmless current surges

PLUS Greater Current Limitation to restrict fault currents to a LOW PEAK

FUSETRON Low-Peak Fuses can be interchanged with FUSETRON dual-element Fuses.

Where their use is required in any part of the electrical system, they can be installed without upsetting proper coordination over the range of useful loads and normal faults.

Hence, their application requires no testing or complicated calculations.

They are designed for use to protect circuits and components that might be damaged by the thermal and mechanical stresses of peak fault currents if other protective devices are used.

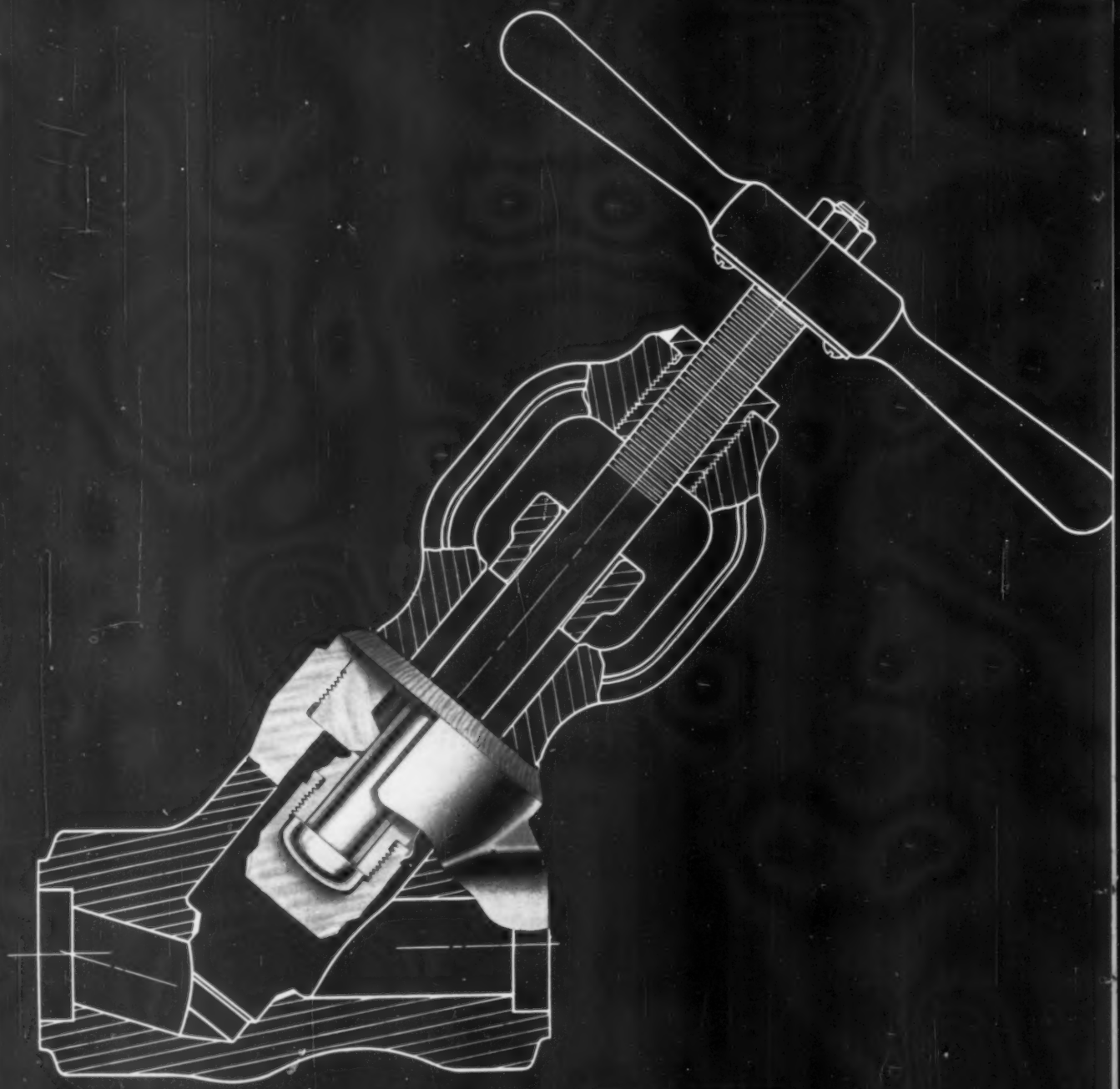
If planning new installations, keep FUSETRON Low-Peak Fuses in mind for those locations where peak fault current must be held to a low value.

BUSSMANN MFG. DIVISION

UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

McGRAW EDISON

For more data circle 511 on Post Card



EDWARD UNIVALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Shoulder, thread and weld make

Superior "Univalve" Body-Bonnet Joint

Edward valve researchers were assigned three main goals in developing the Univalve* . . . first, design a globe valve for high pressure-temperature service—that would *stay* leak-proof . . . second, eliminate—as far as possible—the necessity for maintenance . . . third, fabricate all pressure-containing parts of forged steel for maximum strength and soundness.

How well they succeeded is illustrated by this fact: in many hundreds of advanced temperature-pressure applications all over the world, Edward Univalves have given consistently superior service. The *reason* for this is simple . . . Univalves, properly maintained, simply do not leak.

WELD SEALS JOINT

In the Univalve, a bead of fine-grained weld seals the body-bonnet joint to maintain perfect pressure tightness in any service. A guiding section above the threads protects them from the seal-weld; the threaded section and body shoulder carry the pressure load and insure accurate alignment. The rugged threaded bonnet—with opening just large enough to accommodate the stem—provides a pressure-tight backseat. The radiused disk nut contacts the beveled bonnet backseating surface . . . isolates packing from line pressures and temperatures . . . stretches packing life.

While the Univalve rarely needs attention, even its tough integral Stellite seating surface *can* become scored under some conditions. To strip for inspection and possible re-lapping, the seal-weld is easily removed by machining or grinding or with carbon arc or oxy-acetylene scarfing tip. Besides simple disassembly and positive backseat advantages, Univalve's one-piece gland eliminates possible small parts loss during repacking.

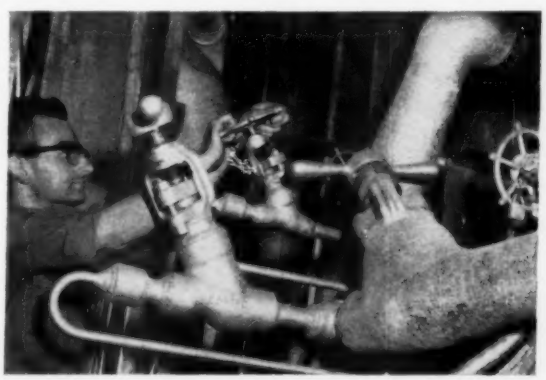
IMPORTANT UNIVALVE FEATURES:

Streamlined Flow Path reduces pressure drop, minimizes wear-producing turbulence. Univalve meets requirements for blow-off service.

Simple Packing Adjustment keeps packing maintenance down. Sturdy gland bolts, roomy yoke, one-piece forged gland.

Easy Open—Tight Close Operation of all Univalves 1¼" to 2½" made a reality with the exclusive Edward Impactor* handle.

Continuous Stellite Ring applied to body and disk, retains hardness under temperature and resists wear.



4500 LB UNIVALVE in service at Ohio Power Company's supercritical Philo station.

*T.M. Reg. U.S. Pat. Off.

IDEAL FOR BLOW-OFF SERVICE. Univalves meet ASME Code for blow-off service and are adaptable for all high pressure installations.

EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1202 West 145th Street, East Chicago, Indiana

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

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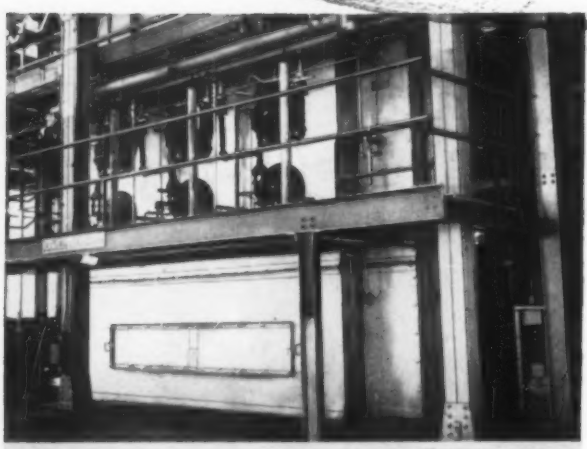
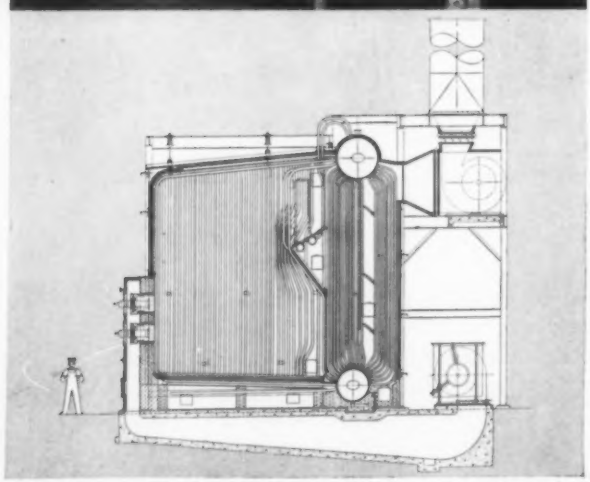
IT'S 100% ....





2 Repeat Orders make it 100% Erie City at Casper, Wyoming

1946

2 — 115,000 lbs./hr. steam generators

1953

1 — 115,000 lbs./hr. steam generator

1956

1 — 115,000 lbs./hr. steam generator

Significant Data:

Boiler Capacity	115,000 lbs./hr.
Operating Pressure	225 lbs.
Design Pressure	250 lbs.
Total Temperature	450° F.
Superheaters	Erie City
Firing	Oil and Gas

• ERIE CITY at CASPER, WYOMING

TEXACO
REG. T. M.

Water Conditions . . . Tough Steam Quality . . . . . Tops

• Proof of the pie is in the eating. In 1946 the Texas Company of Casper, Wyoming installed two 115,000 lbs./hr. boilers, liked what they got, and came back for more in 1953 and 1956. Repeat business is good business because it shows customer satisfaction.

Especially gratifying were these repeat orders because they involved working with tough water conditions. Starting with river water — high in hardness and containing abnormal quantities of dissolved and suspended solids — the properly designed Erie City steam separators, steam scrubbers and boiler layouts produce top quality, clean, dry steam.

Such repeat business results from a thorough understanding of the problem and the application of sound engineering, top quality materials and skilled workmanship. Investigate the use of Erie City Steam Generating equipment in your plant — write for Bulletin SB-5082B

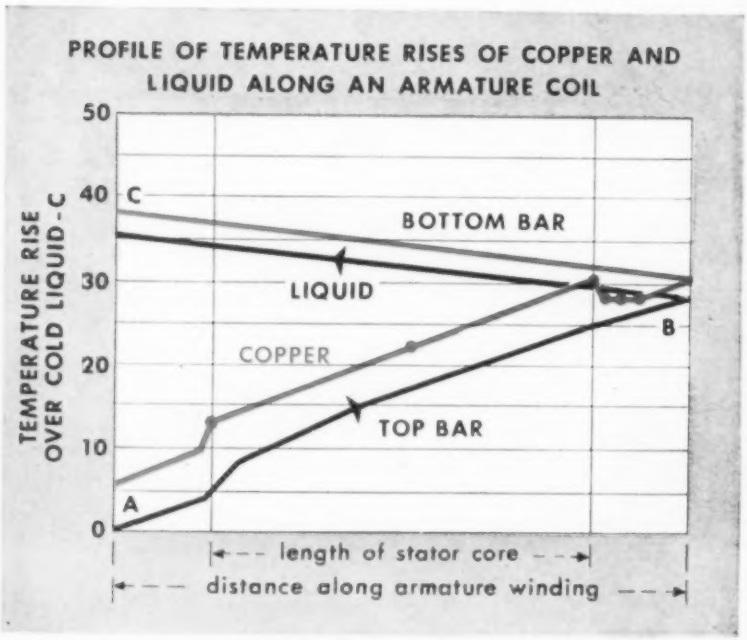
ERIE CITY
Since 1840

You can depend on Erie City for sound engineering

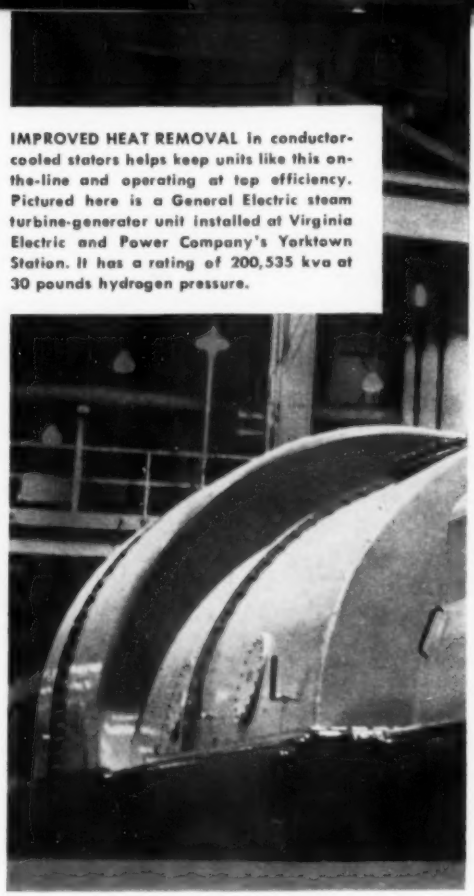
ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
FIRE AND WATER TUBE PACKAGE BOILERS • WASTE HEAT BOILERS
OIL AND GAS BURNERS • STOKERS • PULVERIZERS

For more data circle 513 on Post Card



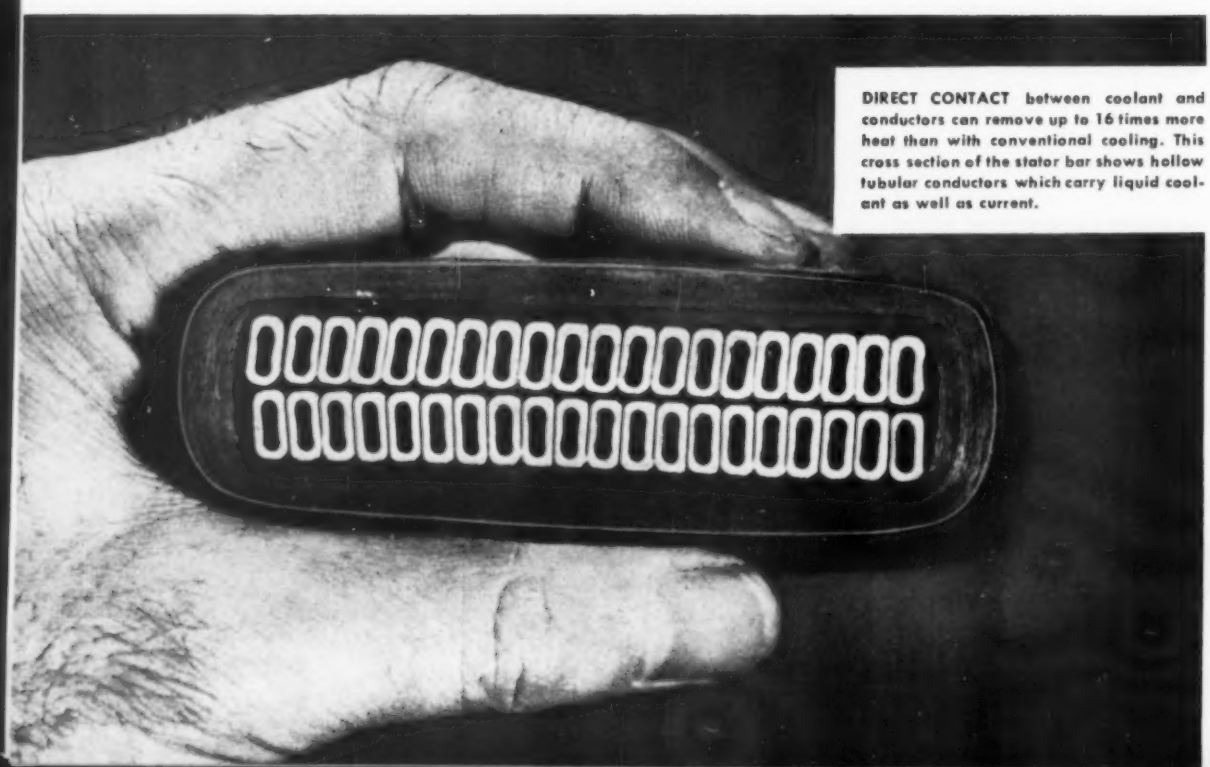
AUTOMATIC TEMPERATURE REGULATION of stator is permitted with liquid cooling. This chart shows how copper temperature remains within a few degrees of the liquid coolant.



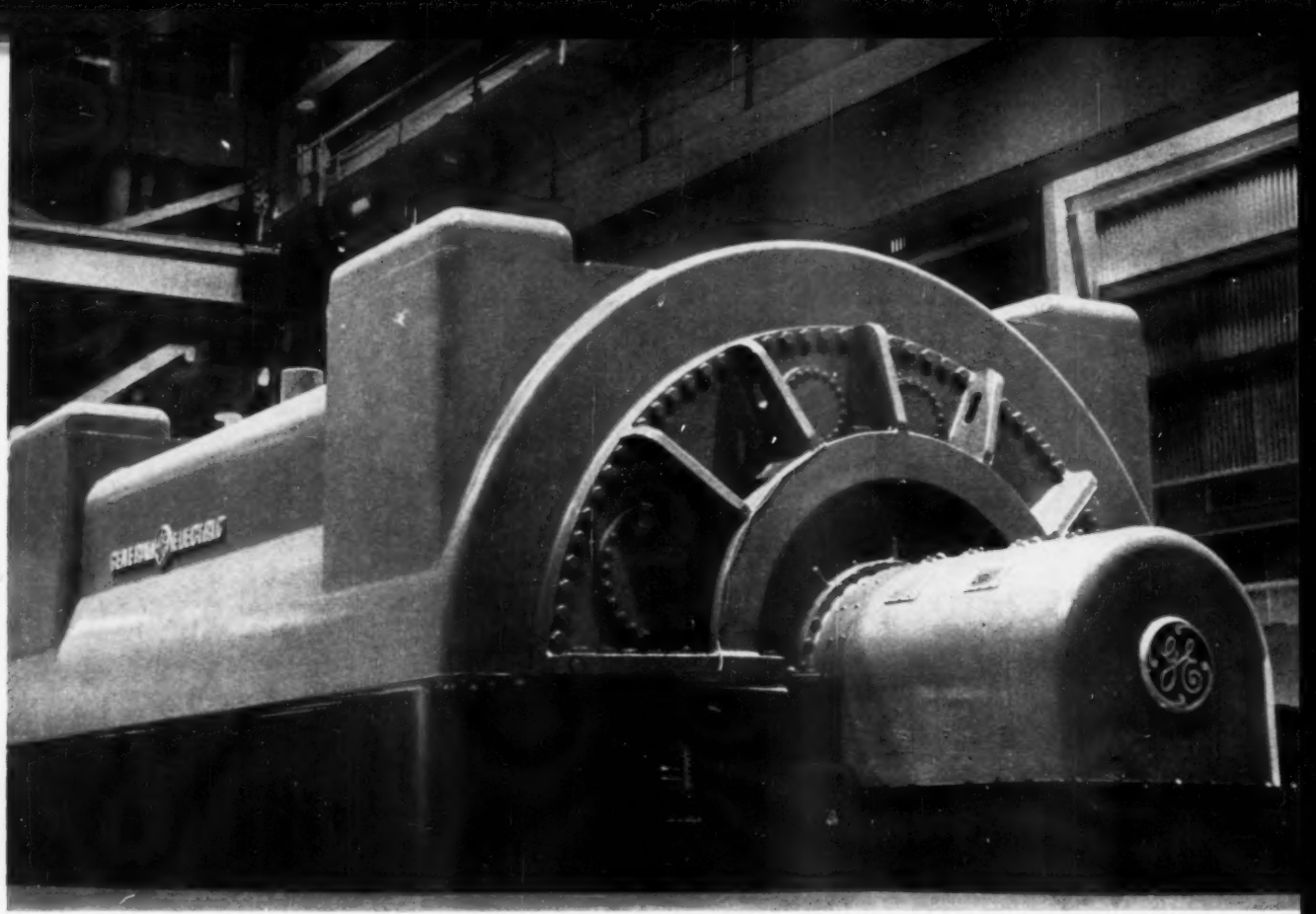
IMPROVED HEAT REMOVAL in conductor-cooled stators helps keep units like this on-the-line and operating at top efficiency. Pictured here is a General Electric steam turbine-generator unit installed at Virginia Electric and Power Company's Yorktown Station. It has a rating of 200,535 kva at 30 pounds hydrogen pressure.

WITH GENERAL ELECTRIC CONDUCTOR-COOLED GENERATOR STATORS . . .

Liquid cooling removes up to 16 times



DIRECT CONTACT between coolant and conductors can remove up to 16 times more heat than with conventional cooling. This cross section of the stator bar shows hollow tubular conductors which carry liquid coolant as well as current.



more heat, permits higher unit ratings

HOLLOW-STRAND STATOR BARS HELP IMPROVE GENERATOR PERFORMANCE

First placed in operation in 1956, liquid-conductor-cooled stators are proving to be one of the most significant advances in generator cooling since hydrogen cooling was introduced some 20 years ago.

Improved Hollow-strand stator bar construction plays an important role in liquid cooling. By providing direct contact between the cooling liquid and the copper current-carrying conductors, *up to sixteen times more heat can be removed than with conventional cooling.* The result is higher generator ratings without appreciable size increase.

Design Features such as use of Micapal insulation for improved dielectric characteristics, bar transposition for uniform temperature, high temperature brazing of liquid connections to prevent leakage, and non-corrosive characteristics of the coolant for longer life, all contribute to more dependable operation.

Improved heat removal for better generator performance is just one of many features of General Electric liquid-conductor-cooled generator stators. Other outstanding advantages are:

Design Simplicity—*Despite higher ratings made possible by liquid cooling, the dielectric system maintains the simplicity and dependability of conventionally-cooled machines.*

Reliable Performance—*Liquid cooling permits automatic regulation of temperature independent of load.*

Dependable Operation—*Closed cooling system minimizes chemical contamination and helps prevent foreign material from entering the system.*

Shorter Maintenance Inspections—*Simple single-stage, low-pressure hydrogen circulating fans permit easy inspection.*

For more information on liquid cooling, write for GER-1231, Large Steam Turbine-Generator Department, General Electric Co., Schenectady 5, N. Y.

254-63

Progress Is Our Most Important Product

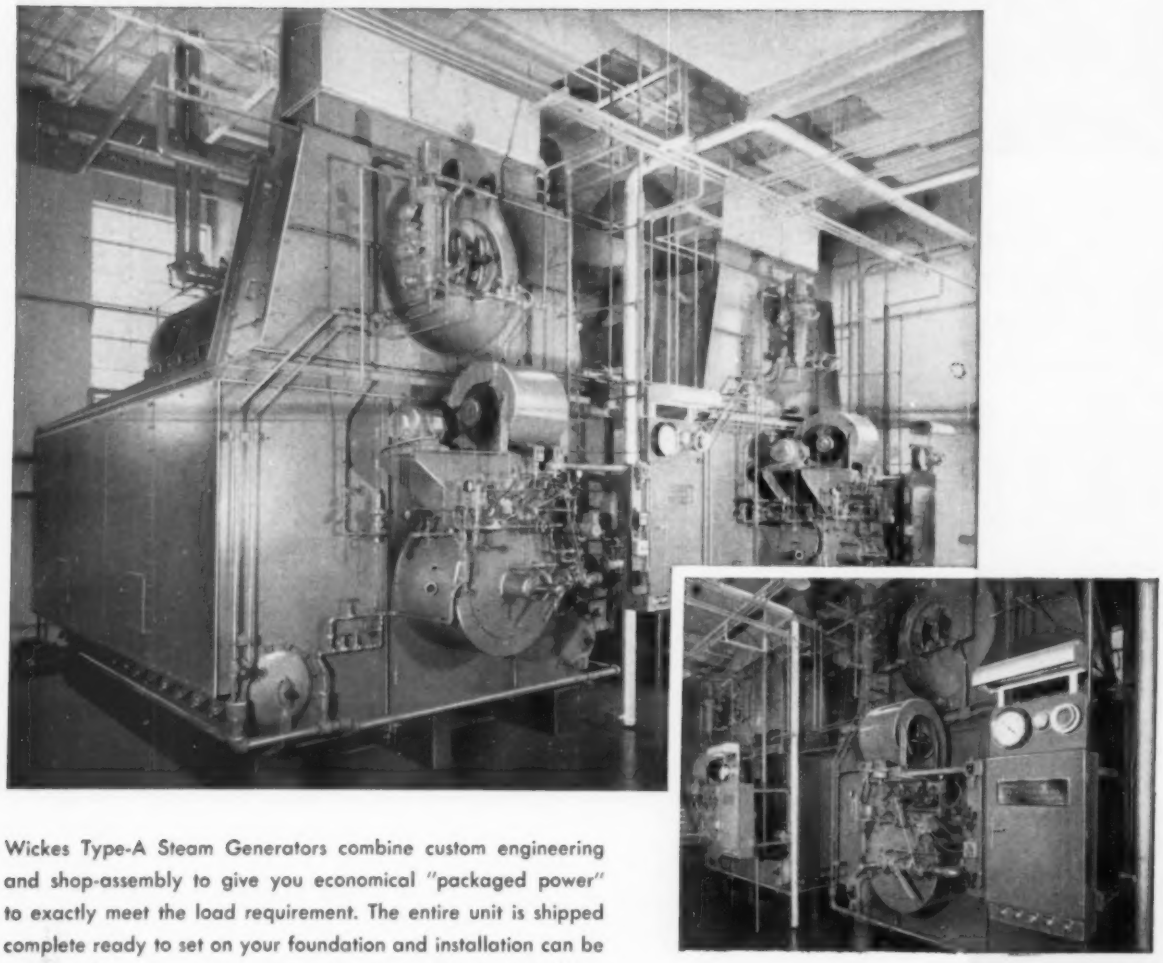
GENERAL ELECTRIC

For more data circle 514 on Post Card

FOR UNFAILING, ECONOMICAL SERVICE,

WICKES Type A, shop-assembled

specified for the Edward W. Sparrow



Wickes Type-A Steam Generators combine custom engineering and shop-assembly to give you economical "packaged power" to exactly meet the load requirement. The entire unit is shipped complete ready to set on your foundation and installation can be made with minimum interruption of your production schedules. All necessary auxiliary equipment including trimmings, soot blowers, feed water regulators and other accessories, are shop-installed leaving field installation at a minimum. From the pressure-tight casing to the oil-gas burner, Wickes type-A water tube steam generators with capacities up to 60,000 lbs. of steam per hour are designed and engineered to be the standard of quality and performance in a variety of industries.

boilers are

hospital

Architects sketch of new Sparrow Hospital.
Architects: O. J. Munson Associates–Lansing, Michigan.
Professional Engineers: E. Roger Hewitt Associates, Inc.–Lansing, Michigan.

One of the most important considerations in hospital construction specifications is the steam generation system, because it must give around-the-clock reliability without failure. It is significant, then, that for the Edward W. Sparrow Hospital in Lansing, Michigan, two Wickes shop-assembled Type-A Steam Generators have been installed to provide a dependable source of heat. The new units, which are housed, in a completely new boiler house, replace the original Wickes coal fired boilers. Each of these two new boilers are capable of producing 18,500 lbs. of steam per hour at an operating pressure of 125 psi. They provide 2250 square feet of heating surface and are equipped with fully automatic Wickes combination oil and gas burners. These units have a design pressure of 160 psi.

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers, and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

WICKES

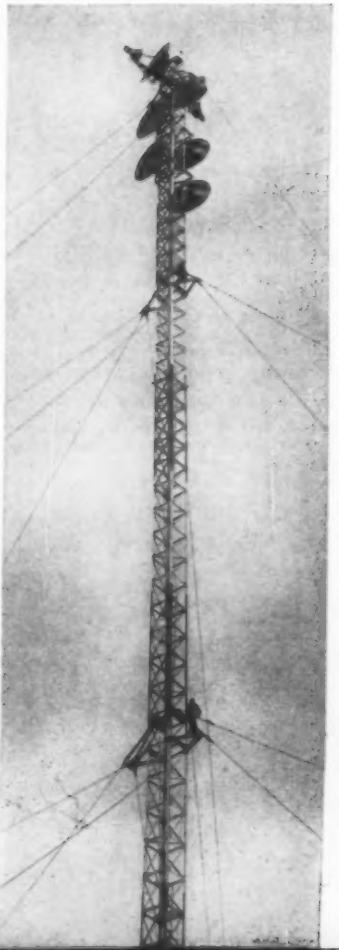
THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 **• *SALES OFFICES:* Albuquerque, N.M. • Boston • Buffalo • Charlotte, N.C. • Chicago Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D.C.**

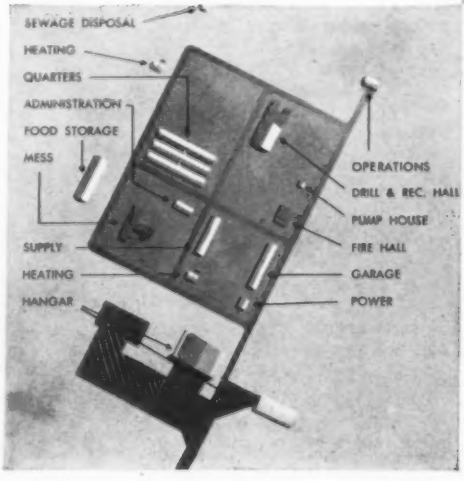
For more data circle 515 on Post Card

1700 tons of GILSULATE



RADAR NETWORK
stretches 2700 miles across Canada;
alerts against invading aircraft.

ALL TYPES OF TRANSPORTATION
were used in building the line.
Here, supplies are being loaded
into helicopter for final leg.
Ships, lighters, trains, trucks,
snow-tractor trains were used
to move 200,000 tons of material.



TYPICAL MAIN STATION LAYOUT
shows diversity of buildings
and services required.
Mid-Canada line confirms
more northern DEW line warnings,
alerts more southern Pine Tree
line at U. S. border.

Read the full story
of the Mid-Canada line
in PIPE INSULATION NEWS.
Ask to be put on our
mailing list!

MARSHALLING AREA
at Great Whale River,
important supply point
during construction.

guard Mid-Canada Radar Line

INSULATES STEAM AND UTILITY PIPES AT SUB-ARCTIC STATIONS

Standing guard along the 55th parallel of latitude is the Mid-Canada line, one of three vital warning systems for our continental defense. It complements the DEW line along the Arctic Circle, and the Pine Tree line just above the U. S.-Canadian border.

To keep these stations operating in all types of sub-arctic weather, steam and hot water are essential. A breakdown in these utility lines could hamper the operation of a station and endanger the lives of the men in it. Gilsulate was used by the Royal Canadian Air Force to protect the underground steam lines at several of these stations.

Each of the line's main stations delivers 12,000-15,000 pounds of steam per hour, using 4,000 feet of pipe. Gilsulate-protected pipes were not buried below five feet; no special trench preparation was made, but forms were used to conserve material. Inspectors from American Gilsonite Company supervised all installations.

Big job or small, near or far, you'll find that Gilsulate can provide the insulating efficiency and corrosion protection for underground hot pipes that you've been looking for. Ask your Gilsulate distributor for a demonstration of the unique properties of this poured-in-place insulation, or write to your nearest office for complete technical details.

FACTS ABOUT GILSULATE

1. **Easy to use**—just pour and tamp... pipe heat does the rest.
2. **Forms 3 Zones** of protection against heat loss and all hazards commonly encountered by buried hot pipes.
3. **Needs no housing or mechanical sheaths:** no mixing, special handling or equipment.
4. **Only needs normal pipe spacing:** for multiple pipe or cramped conditions.
5. **Three types available:**
   Type A for 220°-300°F. temp. range
   Type B for 300°-385°F. temp. range
   Type C for 385°-520°F. temp. range

GILSULATE®

THE TRIPLE ZONE INSULATION SYSTEM FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

AMERICAN GILSONITE COMPANY, SALT LAKE CITY 1, UTAH
Affiliate of Barber Oil Corporation & Standard Oil Company of California
OFFICES AT: 134 West Broadway, Salt Lake City 1, Utah
The Agents Building, 3537 Lee Road, Cleveland 20, Ohio
Distributors in principal countries of the world

For more data circle 516 on Post Card

A NEW CONCEPT IN FURNACE DESIGN

for Multiple Firing of Gas, Oil and a Wide Range of Coals

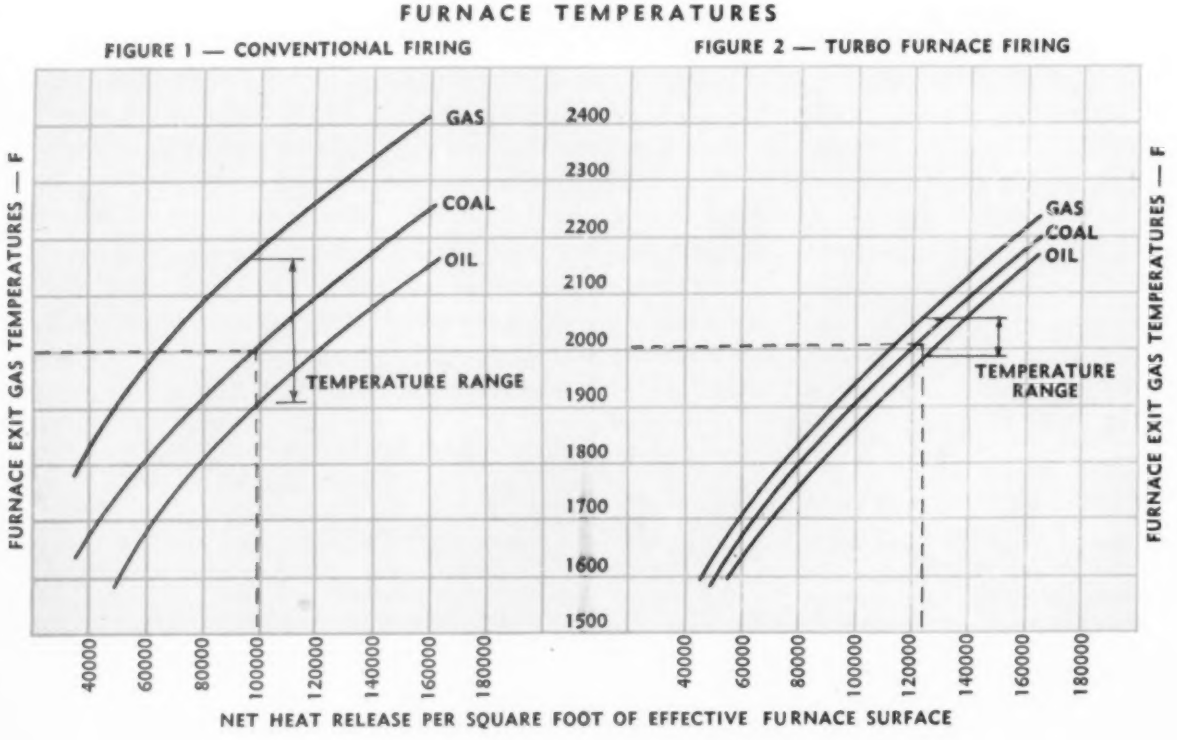
When multiple fuels are to be burned in a steam generating unit, one of the problems to overcome is the variation of steam temperature with the different fuels.

Design Based on Worst Coal That Can Be Anticipated

In designing and engineering a unit in which gas, oil and coal are to be burned, the amount of furnace heating surface supplied depends upon the slagging characteristics of the coal. If the coal to be used has a minimum ash softening temperature of 2100 F., in order to avoid objectionable slagging, the unit must be designed so that the furnace exit gas temperature will be approximately 100 degrees less than the ash softening temperature, or 2000 F.

Conventional Units Need Extensive Steam Temperature Controls

When natural gas is burned in a conventional unit designed for coal with an ash softening temperature of 2100 F., the exit temperature would rise to approximately 2165 F. (Fig. 1) resulting in higher steam temperature than desired.

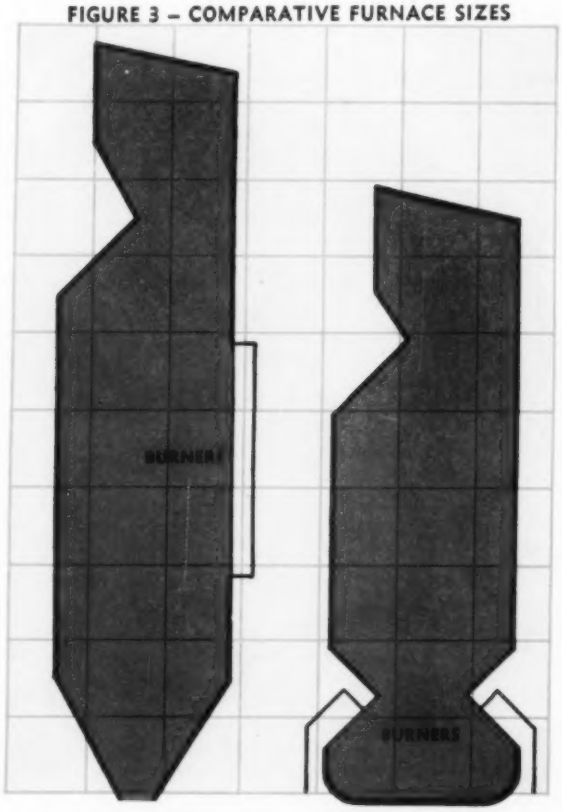


When oil is burned in a conventional unit burning this coal the exit temperature would drop to 1900 F. resulting in a lower steam temperature than desired. Extensive means to control steam temperature must be provided to overcome this variation in steam temperatures.

The Ideal Design for Multiple Fuels

The ideal design of a multiple fuel unit would be one which would produce the same furnace exit gas temperature regardless of the fuel burned. Figure (2) shows the exit gas temperature curves from a Riley Turbo Furnace unit. Note the material reduction in temperature variation with the different fuels. This relative similarity in exit temperatures reduces the problem of steam temperature control to a minimum, and makes it possible to carry approximately the same constant steam temperature range with all fuels.

FIGURE 3 – COMPARATIVE FURNACE SIZES



CONVENTIONAL FURNACE TURBO FURNACE

Uniform Furnace Exit Temperatures

Relatively uniform exit temperatures with all three fuels, when fired in a Riley Turbo Furnace unit, result from the burning of the fuels in the bottom of the unit. Combustion is substantially completed within the confines of the furnace bottom, and with this design, gas burns with a luminous flame. These operating characteristics result in a lower furnace exit temperature with a given heat release per square foot of effective radiant surface.

Overall Unit Size Reduced

To obtain a low furnace exit temperature of 2000 F. with a conventional unit, (Fig. 1), it is necessary to design the unit with a heat release of 98,000 b.t.u. per sq. ft. of effective heating surface. With a Riley Turbo Furnace unit, to obtain this same furnace exit temperature, this furnace heat release would be 122,000 b.t.u. (Fig. 2). This results in an appreciably lower unit, see Fig. (3), another of the many advantages of the Riley Turbo Furnace.

Clean Heating Surfaces

A relatively high temperature is obtained in the Turbo Furnace bottom resulting in rapid and complete combustion. The burners, arranged for opposed firing, produce a uniform distribution of heat without the intense heat zones at the core of the flames that occur with conventional burners. There is no impingement of flame or slag on furnace walls. Heating surfaces stay clean.

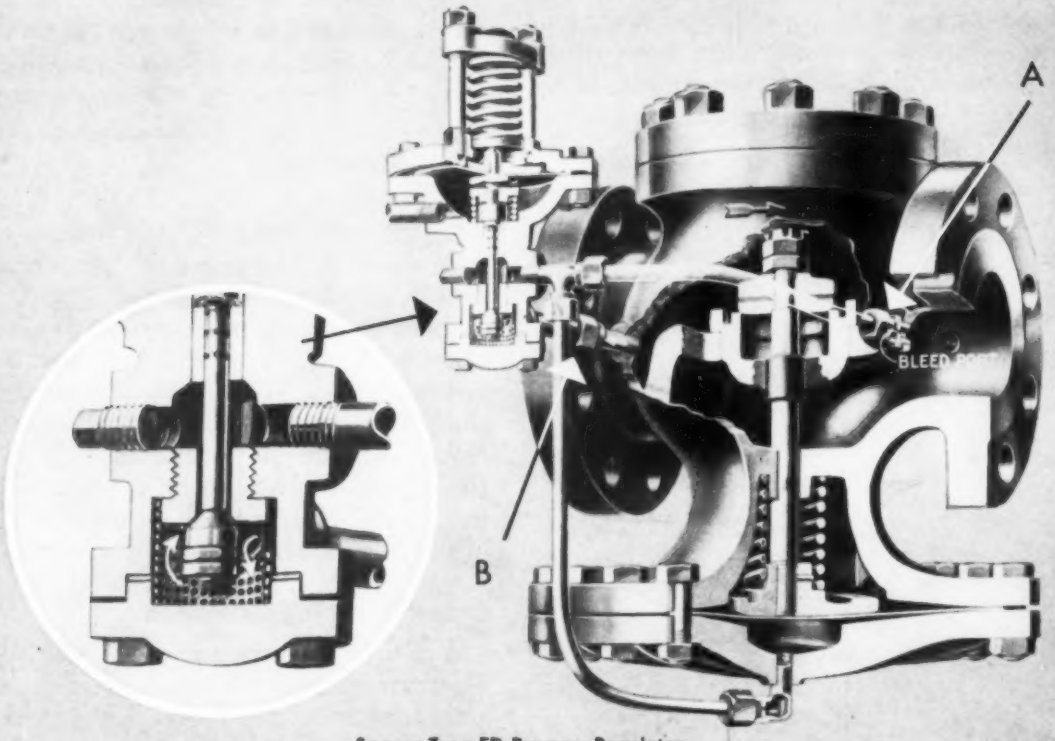
A Riley engineer will gladly give you complete information about this latest Riley development. Write — Boiler Engineering; Riley Stoker Corporation, Worcester, Massachusetts.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT

For more data circle 517 on Post Card

VALVE TIPS:

Advantages of External Pilots in Automatic Regulating Valves



Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at A. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

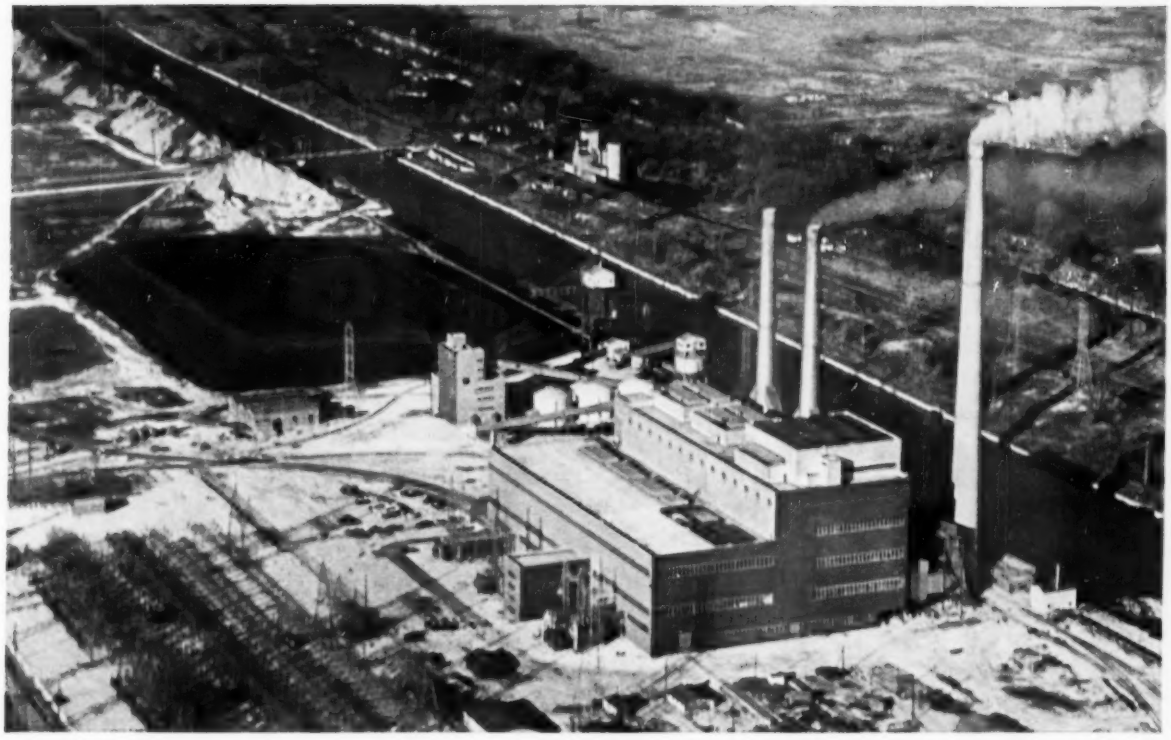
In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

For more data circle 527 on Post Card



Setting new records with world's largest generating unit

As one step in an expansion program totalling two million kw, Chicago's Commonwealth Edison Co. in 1957 placed in operation the largest turbine generator in the world at their Will County Station. This 275,000 kw unit burns 125 tons of coal an hour and uses 204,000 gallons of circulating water every minute.

The project was designed by Stone & Webster Engineering Corporation and constructed by Commonwealth Edison. The close cooperation between designer and builder permitted this unit to be installed in the unusually short period of 28 months.

As a completely integrated organization, Stone & Webster Engineering Corporation is experienced and equipped to handle a single engineering phase or to take full responsibility for the completion of your entire project.

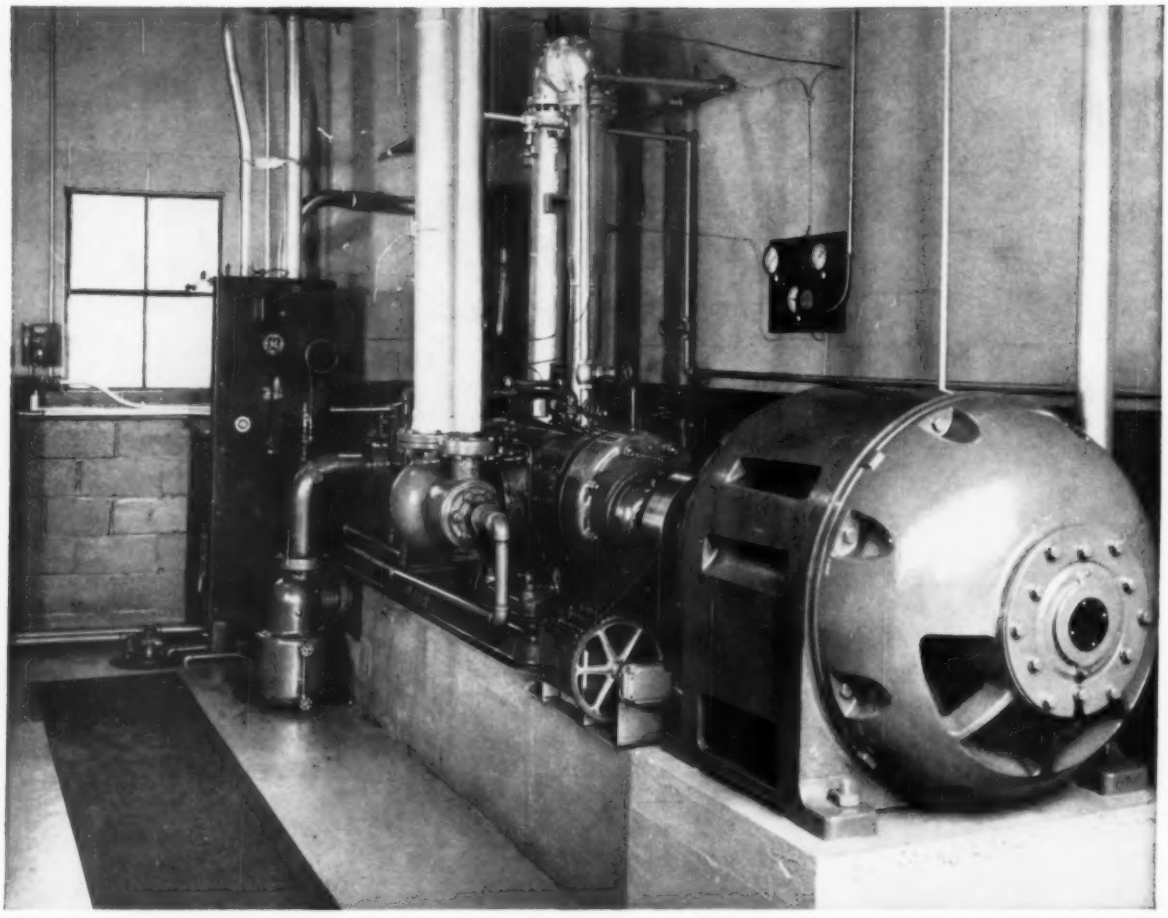
New Cross-Compound Unit has LP turbines with 43-in. last stage blades.

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto



Fuller Rotary Two-Stage Compressor, C135-135H. Capacity 680 c.f.m., 100-lb. pressure, 690 r.p.m., 150 hp. motor.

16,000 HOURS OF OPERATION WITH NO MAINTENANCE

Empire Steel Castings, Inc., Reading, Pennsylvania, installed a C-135-135H Fuller Rotary Two-stage Compressor in April 1953. After 32 months—approximately 16,000 hours of operation—the compressor received a routine inspection, when a new set of blades was installed in the higher-pressure cylinder.

The Empire engineers report no downtime since replacement, although they've added 4,000 operating hours. Prior to switching to Fuller, their former experience with compressors was a different story—as many as several overhaulings in one year. With Fuller equipment furnishing a constant high capacity air supply, production costs have been greatly reduced.

Here's how Empire uses compressed air:

- In the molding department, supplying all air for pneumatic rammers, all squeeze and jolt machines, automatic set-out and lifting apparatus of mold conveyors, automatic shake-out machines, mold cleaning and spraying equipment.
- In the core department, for ramming equipment, spraying and torch drying equipment, core oven operation as well as core blowing equipment.
- In the cleaning department, pneumatic chipping hammers and grinders, blacksmith requirements, sand-blasting, pressure testing and miscellaneous tools.
- In the heat-treating department, heat treating furnace operation and cooling equipment.

To get all the facts and engineering data, write today for Bulletin C-5A.

C-298
3662

FULLER COMPANY
150 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Chicago · San Francisco · Los Angeles · Seattle · Kansas City · Birmingham

Fuller

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

For more data circle 520 on Post Card

ATLAS LUMNITE* IN STACKS AND BREECHINGS

• Concrete linings protect stacks and breechings from corrosive gases and the abrasive action of fly ash.

INSTALLATION: steel stacks and breechings gun-lined at Ohio Edison Company plant, Shadyside, Ohio

- Industrial concretes, made with LUMNITE cement and suitable aggregates, resist heat, corrosion, abrasion, thermal shock — and provide insulation.
- Placement is fast and easy — by guniting, pouring or plastering.
- Downtime is reduced to a minimum because concretes made with LUMNITE cement are ready for service in 24 hours.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For more information, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

"LUMNITE" is the registered trademark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company

L-161

UNIVERSAL ATLAS CEMENTS

USS TRADE-MARK

UNIVERSAL ATLAS CEMENT COMPANY—member of the industrial family that serves the nation—**UNITED STATES STEEL**

OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

For more data circle 521 on Post Card

In the last two years...

All These Improvements

Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.

1. New Cyclo-trell—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

Cottrell Automation System—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

2. Opzel Collecting Electrodes—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

3. New Discharge Electrode Rappers—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

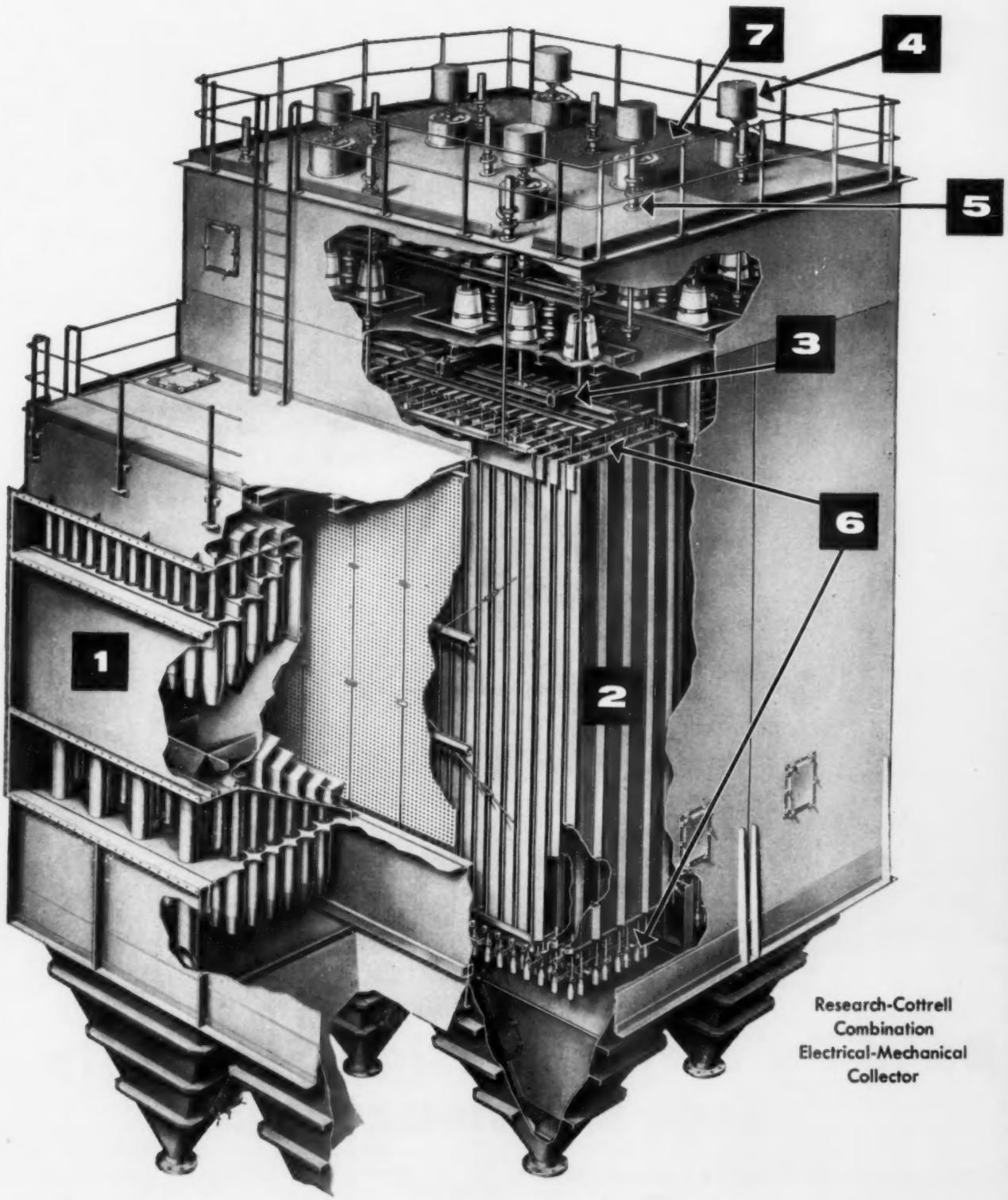
4. Silicon Rectifiers—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

5. M. I. Rappers on Roof—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

6. New Discharge Electrodes—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

7. New Top Constructions—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.

RC-179

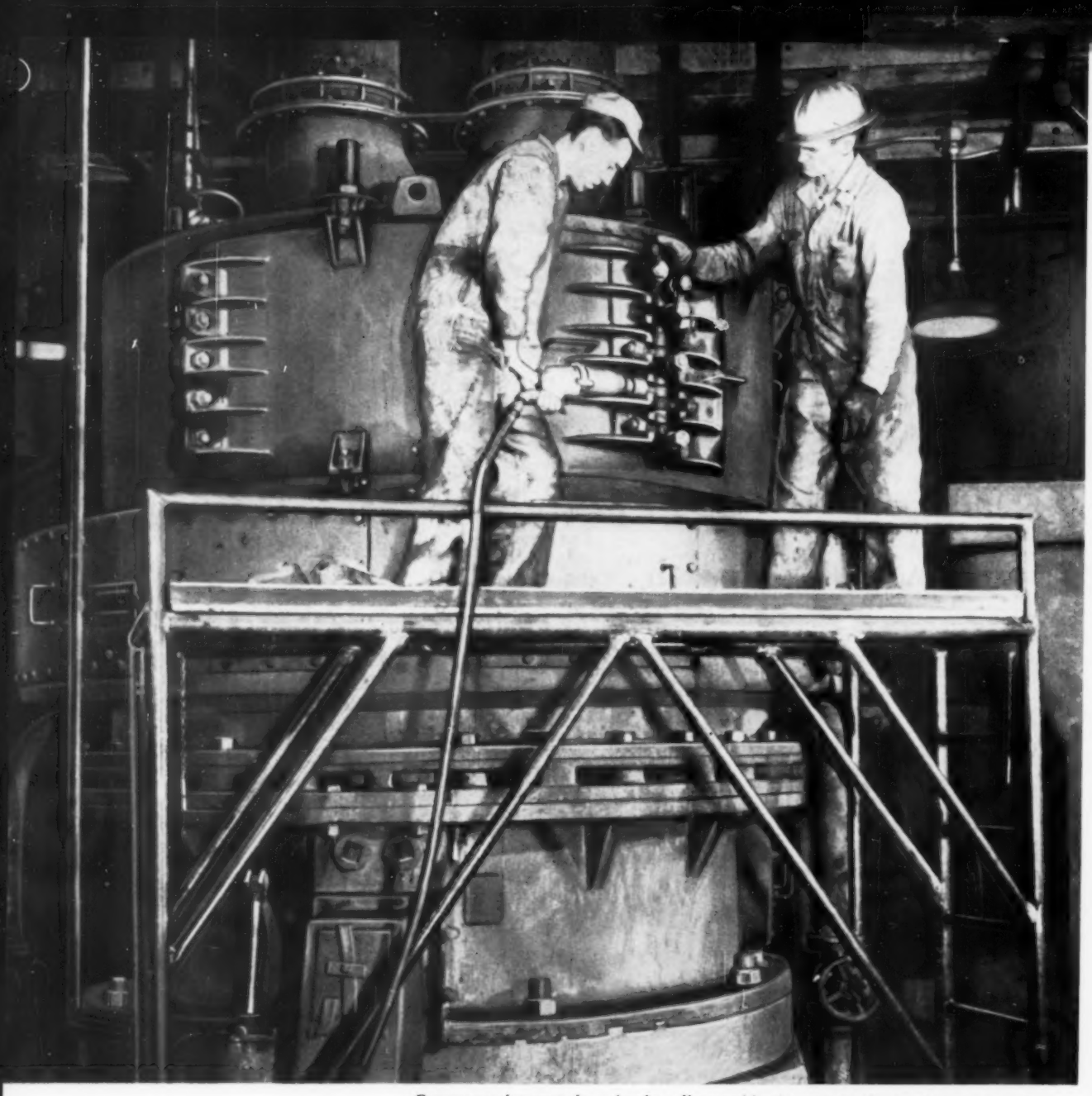


Research-Cottrell
Combination
Electrical-Mechanical
Collector

Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.

For more data circle 522 on Post Card



Representative steps in pulverizer disassembly shown here demonstrate ease and safety of maintenance. Access doors are opened by impact wrenches. Doors are swung back, not removed.

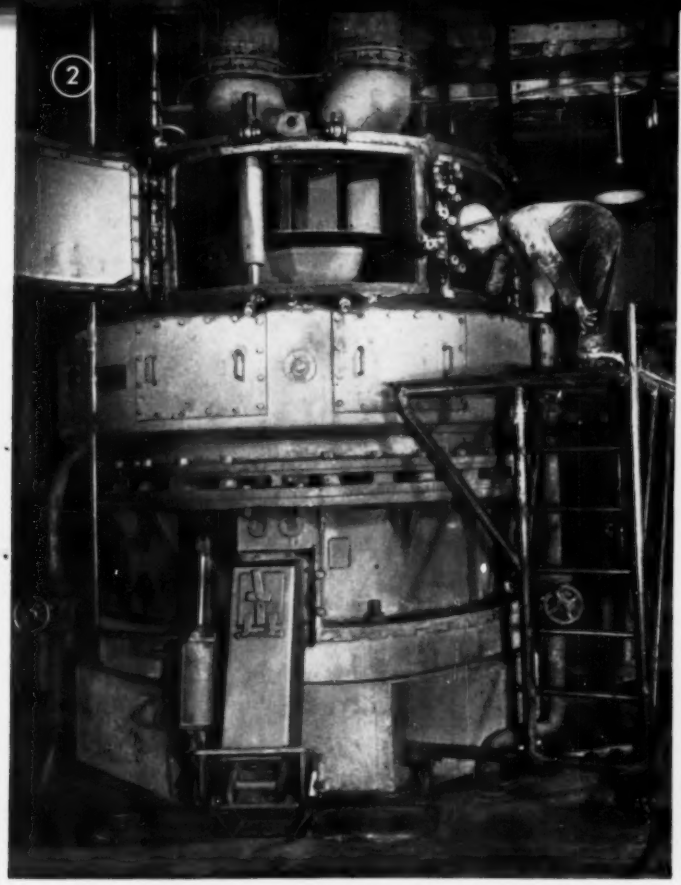
B&W Pulverizer Design Simplicity Cuts Maintenance

Compact Units Handle Low Grade Wet Coal Without Capacity Loss

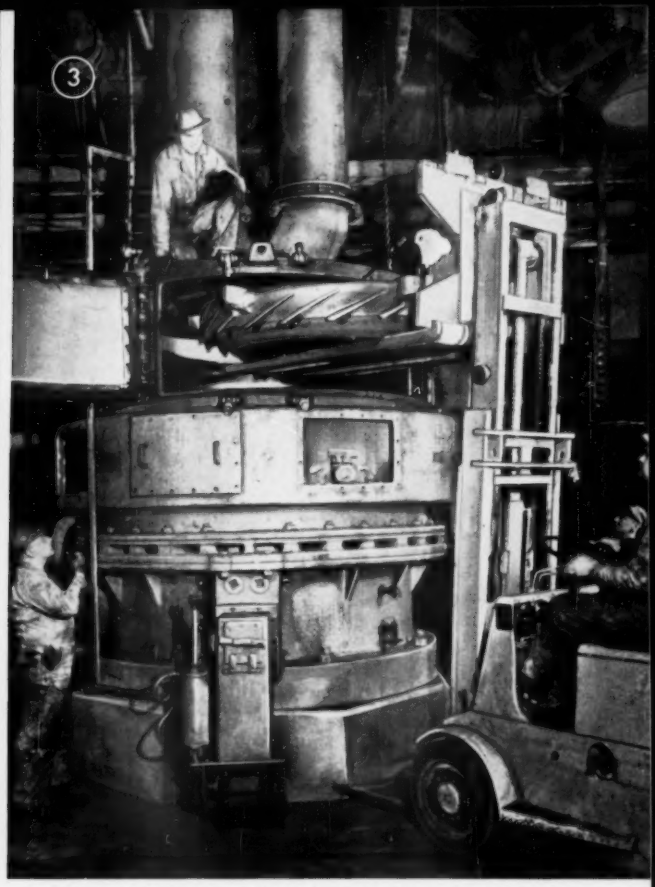
Exceptional output and efficiency records... highlighted by low maintenance... have been established in hundreds of installations by B&W Pulverizers. Their long-range dependability has been accompanied by reduced operating costs.

Fan Maintenance Minimized, shutdowns and maintenance costs reduced because the B&W Pulverizer primary air fan operates with only clean air. As primary air is supplied to the pulverizers under pressure, the fuel piping from pulverizer to burners is greatly simplified.

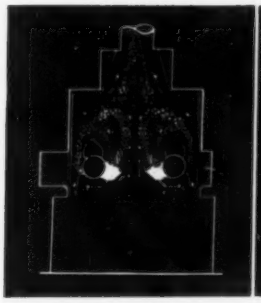
Continuous High Fineness, without reduction in capacity, is assured as grinding surface is maintained with wear. Slow-speed, spring loaded, ball bearing



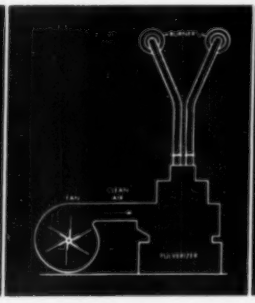
With doors swung open, classifier and spring assemblies are readily accessible for removal. Grinding components are lifted without special rigging.



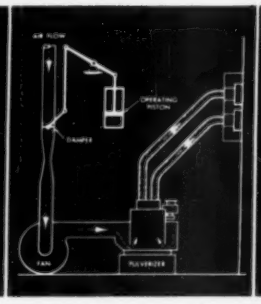
Top grinding ring is lifted by chain falls and, following removal of scaffolding, lifted and transferred by fork lift truck. Lower grinding ring is removed in same simple manner.



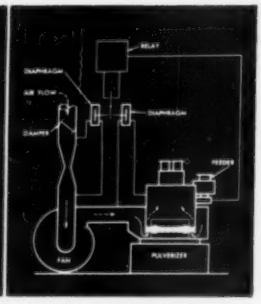
Coal Recirculation assures high fineness, aids drying.



Pressure System eliminates fan wear, simplifies piping.



Air Control maintained at one, simple contact point.



Mill Level Control automatically adjusts fuel-feed.

grinding elements of long-wearing, special alloy material maintain this proper grinding contact throughout their service life. Dependable classification permits only material of proper fineness to leave the unit.

Low Grade Coal, even wet coal, is handled efficiently. Exclusive B&W recirculation of fuel through heated air assures complete grinding, eliminates shutdowns, loss of capacity, and special attention from operators.

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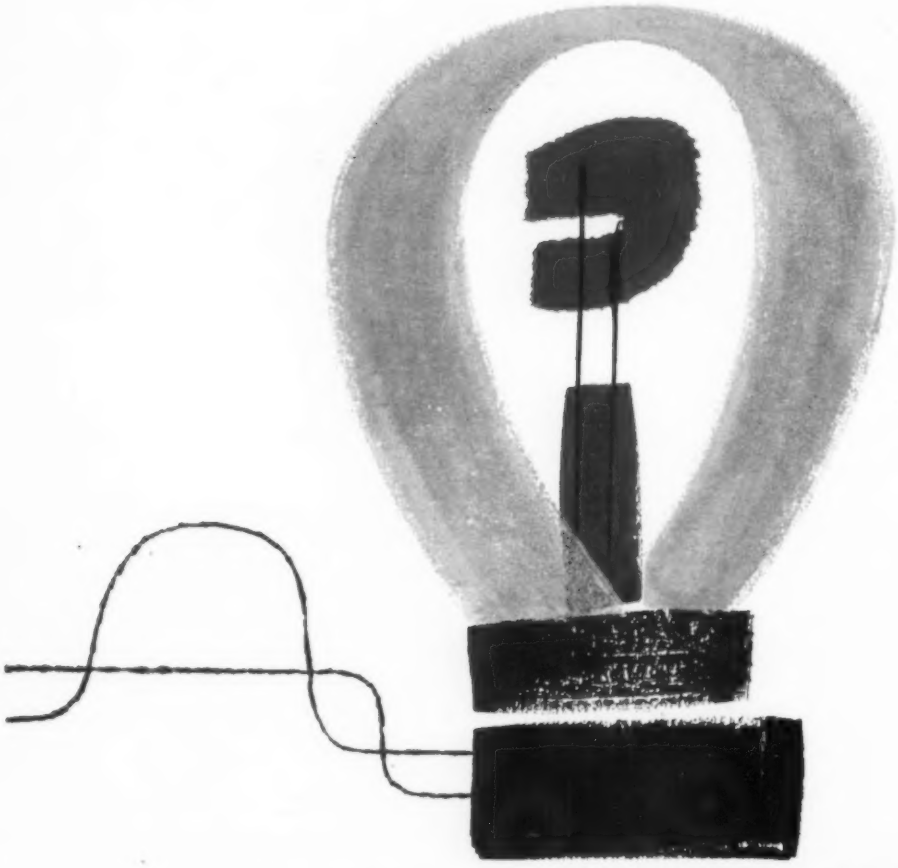

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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HOW TO GET AN ACCESS PERMIT

IN THE COURSE of our travels and editorial correspondence we receive many requests from people in industry, particularly from the small and medium size manufacturers, for information on the commercial aspects of nuclear energy. They would like to get into the nuclear field but do not know enough about it to know what their respective organizations might be able to do in this new, and to a large extent, mysterious field. Few of them realize how much unclassified information is easily available.

Aside from what other information we can give, we usually suggest that these companies or individuals take out Access Permits. The Access Permit Program which was implemented by the AEC in 1955, seeks to encourage industrial participation in nuclear power development. Any domestic firm, organization, or self employed U. S. citizen may apply for an access permit. Application forms for access permits may be obtained by writing to the Division of Civilian Application, U. S. Atomic Energy Commission, Washington 25, D. C.

There are two classes of access permits; Confidential and Secret. Personnel of a Confidential permit holder must have an "L" security clearance after which he may receive information no higher than Confidential. Applicants for "L" Clearances are subject to only limited investigation. Personnel of Secret permit holders must have a "Q" Clearance before they may receive Secret Restricted Data. The granting of a "Q" Clearance is preceded by a full field investigation. There is no charge for the first 25 clearances. After that, $15 is charged for each additional "L" Clearance and $305 for each additional "Q" Clearance.

To obtain access to Confidential Restricted Data an applicant must show that he has potential use for the data in his business. To obtain access to Secret Restricted Data he must demonstrate a specific need for each category of information he requests.

The forms which the applicants receive from the Division of Classification must be filed in triplicate. Normally they may be signed: (1) for a corporation, by a principal officer; (2) for a partnership, by one of the partners; (3) for an individual, by the person himself.

These are the essential facts governing the issuances of access permits. The whole thing is quite simple. For the "L" Clearance category all that is required is a *need to know* and almost any manufacturing organization can demonstrate that.

Should anyone be interested in further particulars concerning not only the Access Permit Program but also on other aspects of atomic energy, it is well worth while to send to the U. S. Government Printing Office in Washington for a copy of Atomic Energy Facts. This 200-page book which sells for $2.00 is worth anybody's serious consideration.

Andrew W. Kramer

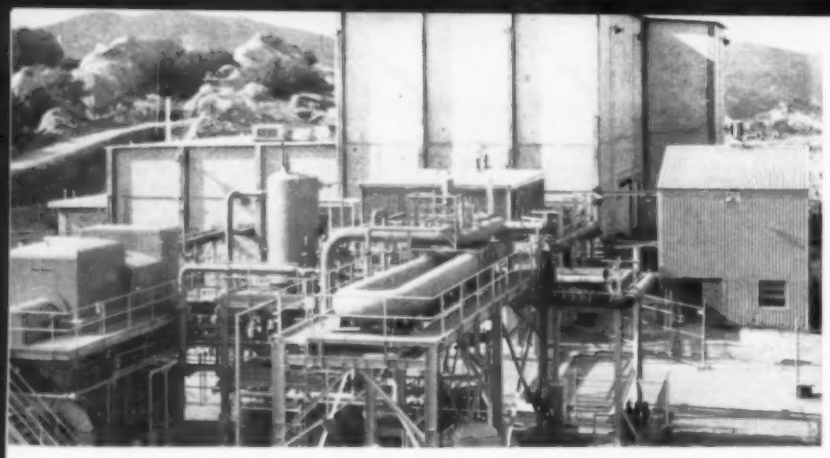


Fig. 1. General view of the Sodium Reactor Experiment. The reactor building is shown in the background. In the foreground can be seen the steam generator at the right and the 7500-kw electric generating unit at the left

SRE Formally Placed in Operation

SRE, the Sodium Reactor Experiment, designed and built for the U. S. Atomic Energy Commission by Atomics International, a Division of North American Aviation, Inc, was formally placed in service on November 14, 1957.

SRE is one of the five reactor experiments originally included in the AEC's original experimental Civilian Power Reactor Program formulated in 1954. It is the second reactor of this group to be completed and to generate electricity. The first is the Experimental Boiling Water Reactor (EBWR) at the Argonne National Laboratory, placed in service just a year ago.

While the dedication of SRE took place on November 14, the reactor had gone critical as early as April 25, last year. Since the initial start-up numerous experimental tests were made to accurately determine the nuclear characteristics of the reactor and to establish satisfactory operation of all the components.

The SRE occupies a 44-acre tract in the Santa Susanna Mountains, 30 miles west of Los Angeles and 10 miles from Atomics International headquarters in Canoga Park. It comprises a 20,000-kw, thermal, nuclear reactor, along with heat transfer and service systems and a steam plant. The original plans provided that the reactor heat be dissipated to the atmosphere in air-cooled heat exchangers but later a parallel-connected steam plant was provided to generate electric power. This arrangement increases flexibility, since the reactor may be operated either with the air-cooled heat exchanger or with the steam plant as the heat sink. Installed by the Southern California Edison Co, the steam plant has a capacity of 7500 kw and can produce approximately 6500 kw with the reactor operating at its design power level of 20,000 kw, thermal. Reactor heat purchased from the AEC by the utility company at the rate of 45 cents per million Btu is furnished for generating electric power intermittently, as the experimental program permits — for it must be kept in mind, this is an experimental plant. The first electricity was generated July 12, 1957. During the first tests, with operation on an intermittent basis over a 3-day period, the turbine was on the line for 46.5 hr and produced a total of approximately 60,000 kwh.

ATOMICS

General Features of The Reactor

The sodium-cooled, graphite-moderated reactor used in the SRE is a thermal heterogeneous type. Heat is removed by a sodium system which consists of a primary (radioactive) loop which transfers the heat to a secondary (non-radioactive) loop. The system is capable of removing 20,000 kw of heat. A similar auxiliary circuit rated at 1000 kw, thermal, is provided. This auxiliary circuit operates continuously so that in the event of a component failure in the main circuit it would supply emergency cooling. The primary loops are contained in shielded vaults below the floor level in the reactor building.

The reactor core, 6 ft in diameter and 6 ft high, contains a closely packed array of hexagonal canned graphite blocks, the moderating material. Forty-three channels are provided for fuel and dummy elements in the centers of the moderator cans. Many of the assemblies are also arranged with corner channels where three cans meet for operating control and safety rods, and for core temperature measuring instruments. All these elements are suspended from the shield above the reactor. The canned moderator assemblies, plus the similarly designed reflector assemblies, are supported on a grid plate at the base of a 1½-in, stainless steel core tank, 11 ft in diameter and 19 ft high.

Sodium enters above the core through double-walled pipes, with helium between the walls (the annulus) to insulate the sodium from the relatively hot tank walls. These pipes lead to a plenum chamber at the base of the tank, into which the sodium is discharged. The main body of sodium (93 per cent) flows upward through channels provided in the moderator assemblies, removing heat from the suspended fuel elements. Approximately 7 per cent of the sodium goes to a separate plenum, where it is routed through the 0.17-in. gaps between the moderator cans and through corner channels for cooling zirconium cans or rods and special assemblies. The hot sodium from the core flows from a 6-ft deep pool above the graphite assemblies through outlet pipes leading to the main and auxiliary primary loops.

Proceeding radially outward from the core tank is a 5½-in. thermal shield of cast iron and a ¼-in. steel outer tank which can contain sodium in the event of a leak in the core tank. Metal bellows to provide gas seals and allow for thermal expansion are installed at the top of the reactor tank and the outer tank. The outer rank is radially contained in 12 inches of thermal block insulation, a ½-in-thick carbon steel liner, and 3 ft of high density concrete. The liner serves as a form for the concrete and has 28 one-inch cooling pipes attached to remove the small amount of heat generated in the concrete plus the heat conducted across the thermal insulation barrier. The base of the liner rests on a concrete pad 29 ft below the floor level.

Hexagonal graphite blocks are used to moderate and reflect neutrons. There are 47 moderator and 72 reflector assemblies. The 119 individual assemblies allow removal of units if required for maintenance. All moderator elements and many of the reflector elements are canned in zir-

conium; reflector elements adjacent to the core tank, including partial elements, are canned in stainless steel instead of zirconium. Canning is necessary to preserve the low-capture cross section, which would be greatly increased if sodium were allowed to penetrate the pores of the graphite.

Control and Safety Rods

Each of the four control elements consist of a column of boron-nickel rings assembled on a tube which is moved in a stainless steel thimble extending down from the top shield into a corner channel position in the core. The Mark I design includes a ball-nut screw assembly for vertical motion. Experiments with this design, while successful at ordinary temperatures, indicated limited life for control rods which must operate with the ball-nut at 1100 F, the calculated temperature for the mechanism at full reactor power. As a result, a Mark II design of control rod was undertaken to locate the critical parts above the reactor top shield in a lower temperature zone. Two Mark II rods are now installed for regulating action (0.3 ft/min) and two Mark I rods for the shim action (3 ft/min). Each control rod reduces the reactivity by about 1.2 per cent.

The four safety rods are similar to the control rods in neutron poison and thimble configurations and the same considerations relating to temperature that led to the redesign of the control rods also led to a Mark II safety rod design. The new safety rod design consists of a chain drive attached to a magnet which in turn holds the tube on which the poison column is supported. A shutdown signal results in a loss of power to the magnets and the consequent dropping of the rods.

Design and development work on improved control and safety rods is continuing, the object being to place as much of the mechanism as possible below the reactor floor level to simplify the fuel loading procedure.

The top shield is made of high-density concrete, 6 ft thick and consists of a fixed stainless-steel stepped ring shield, 15 ft in diameter, with a central loading face stepped shield 11 ft, 8 in. in diameter and weighing approximately 75 tons. This loading-face portion of the shield contains stepped casings for 81 small plugs, most of which are located over the corner or center channel positions in the core. In addition to the 81 small plug casings, provision is made for three intermediate sized plugs, two 40 inches in diameter and one 20 inches in diameter so that the canned graphite assemblies can be removed and replaced without taking off the loading face.

Cooling lines and electrical leads are routed across the top of the loading face just beneath a steel cover plate and within a two-inch-thick layer of removable steel shot, to provide for possible replacement of lines and to prevent lateral "shine" from an irradiated fuel element as it is being removed from the core. Thermal radiation to the underside of both top shields is reduced by reflective insulation in the form of a series of horizontal, thin stainless steel plates suspended from the shield. There are 13 such plates, 1/32 inch in thickness, separated by a space of $\frac{3}{4}$ inch. The steel plate at the bottom of the loading face and ring shields is in thermal contact with a $1\frac{1}{2}$-inch thick lead layer in which tubing is embedded for circulation of tetralin for cooling.

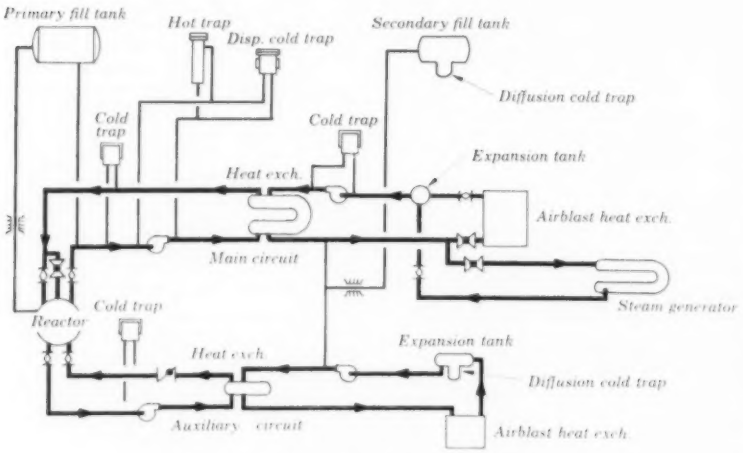


Fig. 2. Diagram of the SRE sodium systems

Fuel Elements

The fuel elements consist of a cluster of 7 rods suspended on a common hanger which is in turn attached to a plug in the loading face shield, so the entire cluster can be removed and replaced at one time. The rods, 6 ft long, are made of metallic uranium slugs, sealed in a thin stainless steel-jacket tube, with a liquid sodium-potassium alloy contained in the tube for thermal bonding. The standard fuel slugs, which are 0.75 inches in diameter and 6 inches long, are made of alpha rolled, beta heat-treated, unalloyed, slightly enriched uranium. The seven rods forming each cluster are retained at their upper ends by a forging. At the lower end they are constrained in the axial direction but are free to move in a vertical plane to allow for thermal expansion. The six outer rods are wrapped with a helical wire to prevent physical contact of the rods with each other and with the zirconium channel tube. Alternate rods are wrapped in counter directions to produce a maximum mixing of the flowing sodium. The reactor flow is orificed among the individual fuel channels. Individual fuel elements have orifice plates near their lower ends which distribute the flow among the channels so that the maximum fuel temperature will be the same in all channels. The temperature of the exit sodium from each channel is

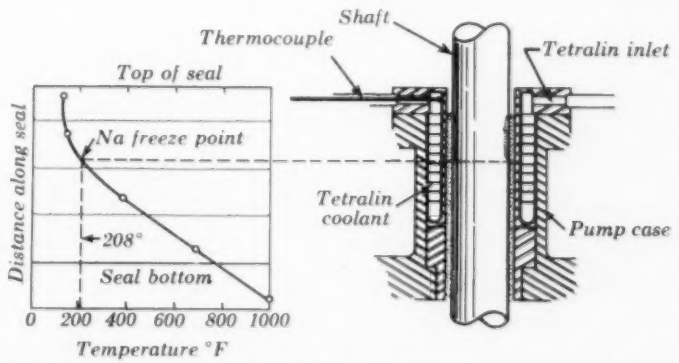


Fig. 3. Detail of the SRE pump shaft freeze seal. The sodium around the shaft is frozen by tetralin coolant

measured by a thermocouple in the hanger rod, and the actual uranium temperatures can be measured by special thermocouple installations in some of the elements.

It is planned to operate the SRE so that a maximum uranium metal temperature of approximately 1200 F is attained in the center of each fuel element, a value which is below the alpha-beta phase transition of uranium metal. During normal operation there will be a pressure drop of 2.5 psi across the central fuel element and 1.5 psi across its orifice plate, making a total of approximately 4 psi. The flow in this central tube will be 5 ft per second, corresponding to 17,500 pounds of sodium per hr.

Sufficient reactivity for criticality was obtained with a loading of 33 fuel elements of the type described. It is expected that full power operation will require a total of 43 fuel elements with the present enrichment, with the average thermal neutron flux in the core around 3.5×10^{13} n/cm^2 sec. The total fuel loading at present is about 3000 kg of uranium enriched to 2.78 weight per cent in the uranium-235 isotope.

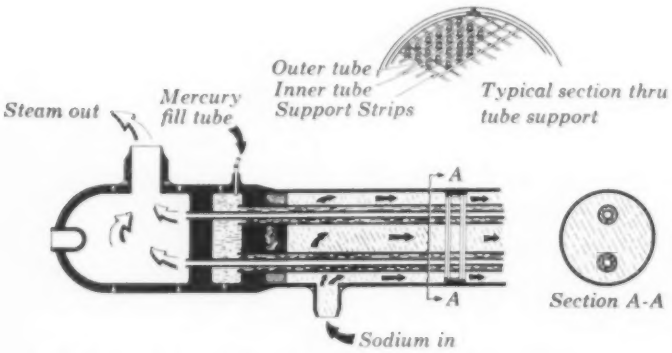


Fig. 4. Section showing the construction of the steam generator

The Sodium System

Sodium will carry heat at high temperatures without pressurization. Because of this and other excellent properties it was chosen as the heat transfer medium. The concept shows promise for producing high quality steam comparable to that used in modern conventional power plants. The boiling point of sodium is 1620 F, and its fluid dynamics are similar to those of water. The melting point is 208 F, and thus the metal is relatively easy to keep in the liquid state.

Main and auxiliary circuits are both divided into primary and secondary sodium loops. The primary loops conduct reactor heat to the secondary sodium loops through the intermediate sodium-to-sodium heat exchangers. The primary circuit flow through the reactor core is exposed to neutrons and becomes radioactive — a gamma emitter with a half life of 15 hours — while the secondary sodium is non-radioactive. The primary system is contained in shielded nitrogen-filled galleries below the floor level, a feature not required on the secondary sodium circuits. The auxiliary circuit was installed to remove reactor *after glow* heat during reactor shutdown or if the main system should fail.

The return sodium from both the main and auxiliary loops enters the core at 500 F. At full power the sodium exit temperature is 960 F. The secondary loops operate at temperatures approximately 60 degrees lower than those in the primary loops. At full power with the normal temperature gradient, the sodium flow in the main system is 485,000 lb per hr, and the auxiliary system flow is 24,250 lb per hr.

Sodium Piping, Valves, Etc.

All piping is fabricated from type 304 stainless steel. Welded joints are 100 per cent radiographically inspected. Piping in the main loops is 6 in. in diameter; that in the auxiliary loops is 2 in. in diameter. To heat the piping and vessels in the cooling system for sodium filling, heaters are installed on the thermally insulated pipes and sodium components. During initial filling and periods of shutdown the systems can be maintained at 350 F.

All the blocking and throttling valves in the primary and secondary heat transfer loops use frozen seals. Sodium freezes at 208 F, hence a gland containing circulating liquid tetralin replaces the valve packing and causes sodium in the annulus around the stem to freeze. When the valve is opened and closed, rotation of the stem shears the frozen sodium without leakage. Helium is maintained above the seal to avoid oxidation of the lip of the sodium annulus. A check valve in the auxiliary system prevents backward flow of sodium if the auxiliary primary pump fails. Vapor traps condense sodium and prevent deposition in inert gas lines exposed to a sodium atmosphere. Freeze traps (cooled pipe regions) block sodium from unheated lines.

Pumps

The sodium pumps, one in each of the four heat transfer loops, are modified hot process pumps, similar to the type used in refineries. The principal modifications consist of vertical mounting and the addition of sodium seals at the shaft and at the case. Each of the primary pumps has its case and drive shaft extended sufficiently to pass through the gallery shielding to floor level, where it may be serviced by withdrawing all internal parts through the case into the reactor room. Primary pumps have 3-in. shafts and 13½-in. impellers while those for the auxiliary system have 10-inch impellers. The main primary pump is driven by a 25 hp motor, the main secondary pump by a 50 hp motor, and the auxiliary motors are 2 hp each.

The frozen sodium shaft seal is made at a cooled gland inserted in the space normally provided for the pump packing. Tetralin coolant circulates through this gland and through a cooling coil at the pump housing for the case seal.

Heat Exchangers

The intermediate sodium-to-sodium heat exchangers use a shell (secondary side) and tube (primary side) counterflow arrangement with a U type design. Both intermediate exchangers use type 304 stainless steel throughout with single wall, seamless tubes, ¾ in. outside diameter. At design conditions of 4 ft per second flow in the tubes, the overall heat transfer coefficient is approximately 985 Btu/hr-ft^2/deg F.

Experimental Power Station

Nonradioactive sodium from the nuclear plant circulates through the shell side of the Southern California Edison's sodium-to-water steam generator. This unit not only fulfills the functions of the conventional economizer, evaporator and superheater, but it is also designed to perform under varying heat input temperatures. A constant throttle temperature of 825 F is maintained by introducing feedwater into the steam through a direct-contact attemperator. With the sodium entering the steam generator at 900 F and leaving at 440 F, 88,700 lb of steam will be produced at a pressure of 620 psi and 825 F. As the sodium temperature increases, the steam flow to the throttle will remain the same but about 11,000 lb per hr will be introduced as feedwater through the attemperator. The steam generator, of the once-through type, is a U-shaped stainless steel heat exchanger, nearly 80 ft long. The tubes are double-wall con-

struction with sodium on the shell side and water flashing to steam in the inner tubes. Between the tubes, the annular space is filled with mercury pressurized at 190 psi which serves as a monitoring fluid for detecting tube failure. During start-up, the steam generator is preheated to 350 F by an auxiliary electric water heater. Sodium at 350 F is next admitted and gradually raised to 440 F. As the inlet sodium is heated to 900 F, feedwater is circulated in such a way as to hold the sodium outlet temperature at 440 F.

The turbine is a standard 3600 rpm unit with a calculated heat rate of 11,544 Btu per kwh at rated load. Two stages of extraction steam are used for feedwater heating. Since the primary purpose of SRE is to develop basic reactor technology, the controls are connected initially to cause the steam plant to follow the reactor output, similar to a stream-flow hydro plant.

There are many more interesting features about this plant which cannot be covered in a short article but it should be obvious that this type of sodium-cooled reactor has many advantages. Not only does SRE operate at high temperatures but it does so at low pressures. Low pressure operation means lower construction costs and increased safety. No containment shell is needed nor is there need for high pressure vessels and piping. The reactor and that part of the heat transfer system that is radioactive operate at low pressure and are completely contained in an underground vault. In short, this type of nuclear power plant may have an important place in future atomic energy development. THE END

Accident at Windscale

A report by our special correspondent on the nuclear accident at Britain's Windscale No. 1 Pile on October 10, 1957. Accident occurred during a maintenance operation called the Wigner Release

THE WINDSCALE plutonium plant has been a very important element in Britain's atomic energy program, indeed the Windscale reactors occupy approximately the same place in England's atomic energy program as the Handford reactors do in ours. Situated in Cumberland, adjacent to the site of Calder Hall nuclear power station, Windscale has been producing plutonium for some seven years with practically no interruption except for periodic shut-down for maintenance.

This splendid performance record, however, came to an abrupt end early last October when a serious accident occurred — an accident which will not only put the Pile No. 1 out of service for a long time but which also created severe public disturbance because of the widespread release of radioactive material.

At first the nature of the accident was not clear. There were various rumors of a uranium fire and of water being used to quench the fire but little was disclosed concerning the nature or cause of the fire or why a fire could have attained the proportions it did before being detected. In November, however, the British government published a White Paper which gives all of the known data concerning the accident.

The Windscale reactors are graphite-moderated piles built of graphite blocks in the form of a cube, and having horizontal fuel channels cooled by air which is exhausted to the atmosphere from tall stacks equipped with filters. The graphite core holds several hundred tons of uranium in the form of aluminum-canned slugs.

The Accident

Windscale was one of the first large atomic energy establishments in England and had operated satisfactorily for about seven years. During that time it had been shut down many times for routine maintenance without incident. Strangely enough, it was during one of these routine shut-downs that the accident occurred — during a maintenance operation called the *Wigner release*. The Wigner effect has been known for a number of years, in fact it was predicted by E. P. Wigner in 1942, hence its name. It involves the displacement of atoms from their positions in the crystal lattice structure of solids as a result of fast neutron bombardment. If, as a result of an elastic collision between a fast moving nuclear particle and an atomic nucleus, the energy transferred to the atomic nucleus exceeds a certain minimum value, the struck atom may be displaced from its normal or equilibrium position in the solid lattice. If several atoms in close proximity are displaced in this manner, some will merely be transferred from one equilibrium position to another in the lattice. However, if a knocked-on atom is unable to find a vacant equilibrium site, its final location will be a non-equilibrium position. An atom of this kind is said to occupy an interstitial site and is known as an interstitial atom. For each interstitial atom produced by the action of radiation, there must be a corresponding vacant site in the lattice, possibly at some distance away. The net result is thus a more or less permanent defect in the solid, which, if sufficiently common may be accompanied by a change in its physical properties or dimensions. It is this effect that causes *growing* and *distortion* in the fuel slugs and moderator material of nuclear reactors.

Quite early in the development of reactor operation it was found that this distortion of the core structure could be counteracted by periodic *annealing*, that is, by raising the temperature of the reactor core above the normal operating temperature and keeping it there for a number of hours. During the annealing, the potential energy associated with the interstitial atoms is released in the form of heat. The amount of heat thus released may result in an appreciable rise in temperature over and above the annealing temperature. At Windscale, the annealing temperature was about 200 degrees above the normal operating temperature. It is not always possible to release all of the Wigner energy in a single annealing operation, and at Windscale, on three previous occasions it was found necessary to apply a second nuclear heating some time after the first nuclear heating when it was seen from the thermocouples in the graphite that the release of Wigner energy was coming to a halt before all the graphite had been annealed.

It was during such a second nuclear heating that the Windscale accident occurred. This was applied before it was necessary and the nuclear heating was put in at too rapid a rate. The second heating was applied because it was thought that the Wigner release was dying away and that parts of the graphite structure were therefore going to escape being annealed. The instrumentation of the pile was not sufficient in quantity or distribution throughout the pile to enable a reliable judgment to be made.

A spontaneous release of Wigner energy had occurred in the Windscale No. 1 pile in September 1952 while the pile was shut down. This led to a rise in temperature of the graphite but the rise was not dangerous and there were no harmful effects. As a result of a study of this incident, a procedure was instituted for controlling the release of Wigner energy and eight such releases had been carried out by the end of 1956 in Pile No. 1. The general procedure was to shut down the reactor, arrange the appropriate instrumentation and then cause the pile to diverge (go

critical) with no coolant airflow, thus raising the uranium and graphite temperatures and so starting the Wigner release in the graphite. The release is then self sustaining.

October 7th

In the present instance, the reactor was shut down at 1.13 A.M. on October 7, and the main blowers switched off in preparation for the Wigner release. All steps were taken to make certain the pile was completely shut down. All thermocouples were checked. The pile was first made divergent for the Wigner release at 7.25 P.M. the same day, and the nuclear heating was stopped early the following morning. Some hours later it appeared that the graphite temperatures were dropping rather than rising and it was therefore decided to apply further nuclear heating.

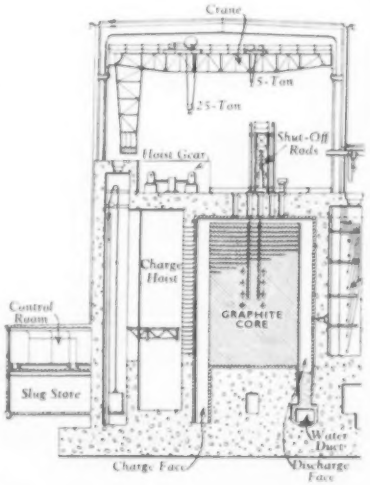
This decision was unfortunate. Subsequent examination of the temperature records showed that some of the graphite temperatures were undoubtedly falling and there were some in which no Wigner release was apparent, but a substantial number of thermocouple readings showed steady increases. However, acting on the observations he had made, the physicist in charge decided to boost the release with a second nuclear heating. Thus, the reactor diverged for the second nuclear heating at 11.05 on Tuesday, October 8. The uranium thermocouples showed a temperature increase lasting for about 15 min after the pile diverged. Subsequent studies of the temperature records indicated that the maximum rate of temperature rise for a few minutes was several times greater than that which is permitted in normal operations. However, the maximum uranium temperature recorded did not exceed the maximum operating temperature.

The rapid rate of rise of the uranium temperatures was noted and the control rods were run in to reduce the pile power and thus allow the uranium fuel to cool somewhat. By that time, however, the damage leading to the accident had probably been done. One or more of the uranium cartridges in the lower part of the reactor had failed.

Faults of Instrumentation

There were two separate and distinct faults of instrumentation affecting the second nuclear heating. First, the uranium thermocouples were situated at the region of highest uranium temperatures during normal operations and were not at the position of maximum uranium temperatures during Wigner release. Because of this the reactor operator was unaware that the uranium fuel in the middle front regions of the pile was probably hotter than was indicated by the readings he was taking. A second deficiency of instrumentation was that the reactor power meter while correct for normal operations read low in the situation prevailing.

The picture that the Committee of Inquiry pieced together revealed that, as a result of the second nuclear heating, graphite temperatures gradually rose through Wednesday, October 9. This led to the oxidation of the uranium which had been exposed by the overheating. The exposed uranium smouldered throughout the course of the day, and gradually led to the failure of other cartridges and their combustion, and to the combustion of graphite. By Thursday evening the fire had spread and was affecting about 150 channels in a region of rectangular cross section. At 11 P.M. on Wednesday various manipulations with the dampers and fans were started in an attempt to bring the temperatures down but with little effect. On the following day the radioactivity meters began to show high readings. These effects suggested to the operating staff the existence of one or more burst cartridges. At 1.45 P.M. on Thursday, October 10, the shutdown fans were started as a necessary preliminary to attempt either to use the scanning gear to detect any burst cartridges or, alternatively, to blow the pile cool but it was found that the scanning gear was jammed and could not be moved.



Sectional view of the Windscale reactor house

Since the scanning gear could not be moved it was decided to remove a charge plug in the charge wall in front of the pile and inspect the channel showing the highest temperatures. When access to the charge hoist had been obtained, inspection of the pile face showed that the uranium cartridges in four of the channels exposed were glowing at red heat.

The first move was an attempt to discharge the glowing channels but they were found to be wedged in owing to the distortion of the cartridges; prolonged efforts continuing until the following morning were only partially successful in clearing these channels. The next move was to create a fire break by discharging channels adjacent to those which were red hot. This succeeded in containing the area of the fire for some hours but did nothing to reduce the temperature of the affected area. During the night an attempt was made to bring down the temperatures by the use of CO_2 brought over from Calder Hall but this proved ineffective because by then the affected region was too hot.

Meanwhile, thought had been given to the possible use of water and by midnight a decision was reached to do this. This was a major decision and soon after midnight the Chief Constable of Cumberland was warned of the possibility of an emergency and men in the factory were warned to stay indoors and wear face masks. By 3.44 A.M. the water hoses were ready to be coupled at 15 min notice. At 7.00 A.M. it was decided that water should be used but that before it was turned on, all factory labor should be under cover. Water was first turned on at 8.55 A.M. but without immediate effect. About an hour later the shut down fans, which had been kept in operation in order to maintain tolerable working conditions on the charge hoist (where unloading operations were being attempted) were closed down. This operation, combined with the continued use of water, caused the fire to subside. Pouring water continued for over 24 hours until, by Saturday afternoon, October 12, the reactor was cold.

Contamination

Shortly after the rise in temperature of the reactor, measurements of the air surrounding the site showed a considerable increase in radioactivity. On October 10 a sample outside the Health Physics Administration Building gave a count of 3000 units compared with a normal level of 200 to 300. It immediately became obvious that radioactive combustion and fission products were passing out of the 400-ft chimney. Iodine 131 was present in far greater proportion than in normal fission products, hence, it was obvious that iodine vapor was coming through the filter but that the major part of the particulate material was being caught. Samples of the milk from cattle grazing in the surrounding area gave iodine-131 contents far above normal and after several hours of consultation with health authorities arrangements were made with the local police and milk marketing board to have milk deliveries from 12 milk producers within a 2-mile radius stopped. This area was

ATOMICS

extended in the days that followed.

While the total amount of radioactivity released during the incident was relatively small, still the fact that the milk contained far beyond the permissible content of radioactive iodine, was sufficient to cause widespread alarm. While no human beings were injured in any way, the strong public reaction gave the government leaders considerable concern about the effect of the adverse publicity on the entire British Nuclear power program. They were quick to point out that the accident at Windscale could not happen at Calder Hall or any of the other gas-cooled nuclear power plants under construction. All the Calder Hall type plants use closed cooling systems. Even if a fire in the uranium should occur in a Calder Hall reactor, it would be confined to the closed primary cooling loop and it could easily be put out by the circulation of the inert cooling gases. Because of the higher operating temperature of the Calder Hall type reactor some of the annealing of the graphite goes on continually and there is far less need for periodic Wigner releases than in the Windscale piles. THE END

Solenoid Valves For Nuclear Power

By ALAN W. CHURCHILL
Chief Engineer, Valve Department
Automatic Switch Company

OUR PLUNGE into the atomic age has developed a new race of physicists, engineers, and technicians dealing in new concepts, new materials, and new methods. The need for regulation, control, and instrumentation has multiplied with every advance and has required the extension of the operating boundaries of existing equipment. As a company that pioneered in the automatic control of flow by electrically operated valves, the Automatic Switch Co has been involved in a multitude of problems arising from the new media to be confined and the controls required. In the ultra-secret days of the Manhattan Area Project, with no knowledge of the ultimate end use, the thousands of valves we were required to furnish ranged from standard to highly special designs to meet requirements we had never previously imagined.

The possible applications for automatic control by solenoid valves is as broad as the field itself. Solenoid valves for parts of the systems, other than the radio-active or primary loop control, present more or less normal design problems. This outline therefore will be confined to the problems of designing electrically operated valves to handle the primary or "hot" portion of pressurized water reactors.

Our company has designed and built 2-way, 3-way and 4-way solenoid valves to handle primary fluid, ranging in size from $\frac{3}{32}$ to 2 in. orifices.

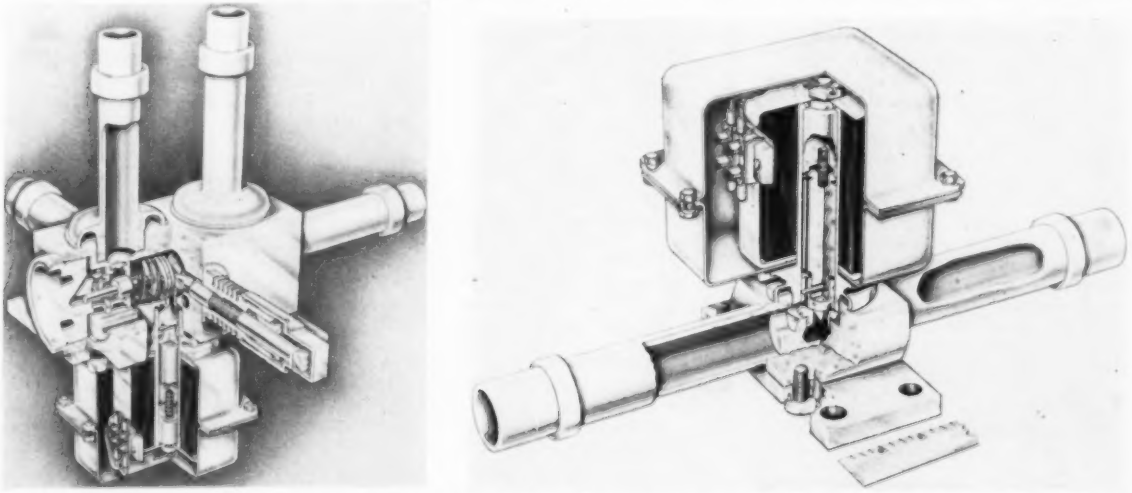
ATOMICS

Need to confine high pressures and temperatures and the limitation on materials imposed by the need to resist the extremely corrosive action of hot demineralized water constitute the first problem to be met by the designer of electrically operated valves. In the primary loop of a closed system, contamination of the circulating water by corrosion products must be avoided; the minutest leak to the surrounding area cannot be tolerated. This immediately limits primary loop solenoid valves to the packless type, and limits materials to corrosion resistant metals, none of which are particularly efficient as magnetic materials for the solenoid armatures. The high pressures and temperatures, and the need for a high factor of safety require heavy walls that in turn introduce large gaps in the magnetic circuit that must be compensated for in the design.

In the hot portions of the system, the fluid being controlled is itself at temperatures approaching the limitations of Class "H" insulation, making it necessary to protect the solenoid insulation by cooling fins, and sizing the coil to provide adequate dissipation of the heat generated by current in the coil itself.

Safety of personnel and of the system itself call for extreme care in all pressure-containing parts handling the primary fluid. Materials must be of specific and certified analysis, with their physical characteristics checked and every inch ultrasonically examined.

Machining required is equivalent to highest instrument quality throughout. Tool scratches, flaws, and burrs, no matter how minute, are taboo.



Solenoid valves for atomic power applications. At the left is a 4-way valve to pilot high pressure water to the operating cylinder of a primary valve system. Valve is stainless steel, rated at 3000 psi, 600 F. Delivers 28 gpm of charging water and vents equal volume of high temperature water. At the right is a 2-way valve used as a control valve in the coolant purification system. This is a normally closed globe valve for operation at 2500 psi, 500 F

The ever-present problem of corrosion and erosion defines the fit of parts necessary to prevent crevice corrosion. Rubbing parts must be Stellited and of different hardness to prevent galling. Seating surfaces must be of Stelliite or Stellited, also. If the application requires tight seating, either to isolate sections of the loop or to minimize pump capacity, the large and rapid temperature changes and the high expansion coefficients of the materials involved, greatly favor poppet type valves as compared to the spool type, with their inherent danger of sticking.

The finished valve must be a completely sealed pressure vessel, with no joints or openings other than the stubs for welding it into the system. Every weld must be made to tight specifications, with every precaution taken to secure sound welds free of cracks or inclusions. Dye-check or Zyglo tests during welding are necessary to insure flawless welds. Each type of joint or material combination requiring welding necessitates investigation of the specific joint with physical and microscopic checks of sample welds, until a proper welding technique and procedure is established.

In addition to the constant inspection of all material parts the final performance tests are well beyond normal commercial practice. Cleanliness is of prime importance. Valves must be almost surgically clean, assembled in a clean area, and be tested on demineralized water in such a manner as to prevent any impairment of their cleanliness. After testing they must be thoroughly rinsed with acetone, dried and sealed, until they are ready to be welded into the system.

Proof testing to 7500 psi and operational tests ranging from 5 to 3000 psi, using demineralized water only, requires special equipment and operation by qualified personnel. A high pressure test loop, operating at 2500 psi, 550F., is required to perform the necessary operational tests at system temperature and pressure. The lead valve of each new design undergoes exhaustive engineering tests, including shock and vibration tests if it is for Navy use.

After completion of all tests, including an accelerated life test, the lead valve is disassembled by cutting the seal welds and checked for damage or wear. All production valves undergo hot and cold operational tests, hydrostatic proof tests, leakage checks, and full electrical tests before shipment.

Solenoid valves in nuclear energy applications perform the same functions as they do in commercial applications. Design fundamentals remain the same, although frequently they go to, and well beyond, what we once considered the end of the scale. However, the special problems and precautions required necessitate bounding every feature of design, manufacturing and test by complete and detailed specifications.

To handle this work efficiently, we have found it desirable to handle all atomic energy design separately from our regular project engineering and to keep production, inspection, manufacturing and test procedure to a large degree under the control of this group and separate from our other production. THE END

New Nuclear Literature

AMONG the many new books, reports, documents and articles relating to the development of the peaceful atom in recent months, the AEC's new 216-page *Atomic Energy Facts* will be of particular value to those wishing to get into the atomic business. This compilation of previously published information is intended primarily as a source book for industrial management but teachers, writers and others interested in atomic energy should also find it useful. It can be purchased for $2 from U. S. Govt. Printing Office. * * Another excellent new AEC publication, one of a more technical nature, however, is *The Attenuation of Gamma Rays and Neutrons in Reactor Shields* a 295-page book by Herbert Goldstein. This is one of a series prepared under contract by outside writers and organizations for the AEC. It represents the most advanced knowledge of reactor shielding and is, therefore, of a specialized nature requiring considerable background knowledge. The shielding of reactors is a subject which cuts across the boundaries of the conventional fields of science and technology. This also is available at $2 from Supt of Documents, U. S. Govt Printing Office. * * From the British Information Services with offices at 45 Rockefeller Plaza, New York 20, N. Y. comes an excellent 58-page pamphlet entitled *Nuclear Energy in Britain*. It contains a detailed description of Britain's ambitious nuclear energy program as well as a brief history of the UK's work in the nuclear field. * * Another British publication of current interest is the British Government's *White Paper*, "Accident at Windscale No. 1 Pile on 10th October, 1957." As mentioned in the article on the Windscale Accident in the preceding pages, this gives all the details of this nuclear accident which created severe public disturbance in England last fall. Copies of this publication can be had from Her Majesty's Stationery Office in London. Price 1*s* 3*d* net. * * A very fine report on The Status of World Nuclear Energy has been issued by the Stanford Research Institute at Menlo Park, California. It was prepared by Ashton O'Donnell, Manager of Nuclear Development for SRI. To obtain first-hand knowledge for this report, Mr. O'Donnell undertook a world-trip, visiting 17 nations. The title of this report is *World Progress with the Atom — Since Geneva*. Copies of the SRI report can be obtained from the Public Relations Office, SRI at Menlo Park. * * The vast range of nuclear science was reflected in the over 200 technical papers presented at the 2nd winter meeting of the American Nuclear Society held in New York recently. Abstracts of these papers are presented in the 76-page final program, available from the American Nuclear Society, P.O. Box 963, Oak Ridge, Tenn. at $1.00 per copy. * * Business executives and others interested in the commercial aspects of the nuclear industry will welcome a little book just issued by the American Management Association, entitled *Profit Perspectives in Atomic Energy — Problems and opportunities*. As pointed out in this special report the race to apply atomic power commercially, on a profitable basis, will be close. Time is the critical element; it takes time to seek out and organize effective teams of scientists, engineers and administrators and this book is designed to help management in that respect. It is available to non-members of the association at $4.75. The American Management Assn is at 1515 Broadway, New York, N. Y. * * From the legislative branch of the U. S. Government come two extremely informative publications, the first, *The Nature of Radioactive Fallout and its Effects on Man* and the second, *Statute of the International Atomic Energy Agency*. These are both reports of hearings before members of the Joint Committee of Atomic Energy and they are available from the Government Printing Office. The former, the one on radioactive fallout is a huge volume of over 1000 pages, complete with charts and diagrams and replete with the testimony of scientific experts. This volume probably represents the most complete compilation of data and information on the nature and effects of fallout that has ever been gotten together. The report on the International Atomic Energy Agency describes the history leading to the formation of this agency, its structure and purpose, together with the various discussions of witnesses before the congressional committee. THE END

Vincent Bicicchi, Pratt Engineer, standing at exterior door of a personnel lock for the Pleasanton, California atomic power plant.

Henry Pratt engineers the...

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The Henry Pratt Personnel Access Lock fulfills one of the most necessary requirements of an atomic power plant. It allows personnel to pass conveniently through the containment vessel to the reactor in such a way that the plant will fully comply with the **AEC code for reactor construction.**

The design emphasizes strength and easy, fool-proof operation. The lock can be built to withstand any practicable pressure, with compression type or pneumatic door seals. Simple operating principles increase its safety factor and include an **interlocking feature** that keeps one door open when the other is closed.

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* See: Nuclear Power Engineering by Henry C. Schwenk, Henry Pratt Company, and Robert H. Shannon, United Engineers & Constructors, Inc. 344 pages, 131 ill., McGraw-Hill; 1957

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J.C.P. & L.'s New Sayreville Addition to have HAGAN INSTRUMENTS AND CONTROLS

Jersey Central Power & Light Company is well acquainted with Hagan controls. Their E. H. Werner Station, South Amboy, New Jersey addition is equipped with Hagan Automatic Combustion Control, 3-Element Feedwater Control, and Hagan Ring Balance meters. Base-loaded, their 62,500 kw addition has been on automatic control since it began operation in 1953. Hagan was again selected for the new boiler addition at the Sayreville Station, Sayreville, New Jersey.

Jersey Central Power & Light's E. H. Werner Station. The most recent unit, shown at the left, is fired by two Cyclone furnaces, the first to be installed in the Eastern United States.

At Sayreville, Hagan equipment will include Combustion Control, 3-Element Feedwater Control, Feedwater Pump Recirculation Control, Principal Metering and Panels. In general, the systems will follow the pattern established at the E. H. Werner Station since the boilers at both stations are fired by Cyclone furnaces, two at Werner and four at Sayreville. The Sayreville boiler will operate to produce 900,000 lbs of steam per hour at 2050 psig and 1050 F with reheat at 1000 F.

Both management and operating personnel are satisfied with the reliability, accuracy and low maintenance costs made possible by Hagan control systems. Why not take advantage of the problem-solving skills developed by more than 35 years of experience with boilers of all types? A Hagan engineer will be happy to work with you on the design of controls for new plants or plant expansions. Write or phone:

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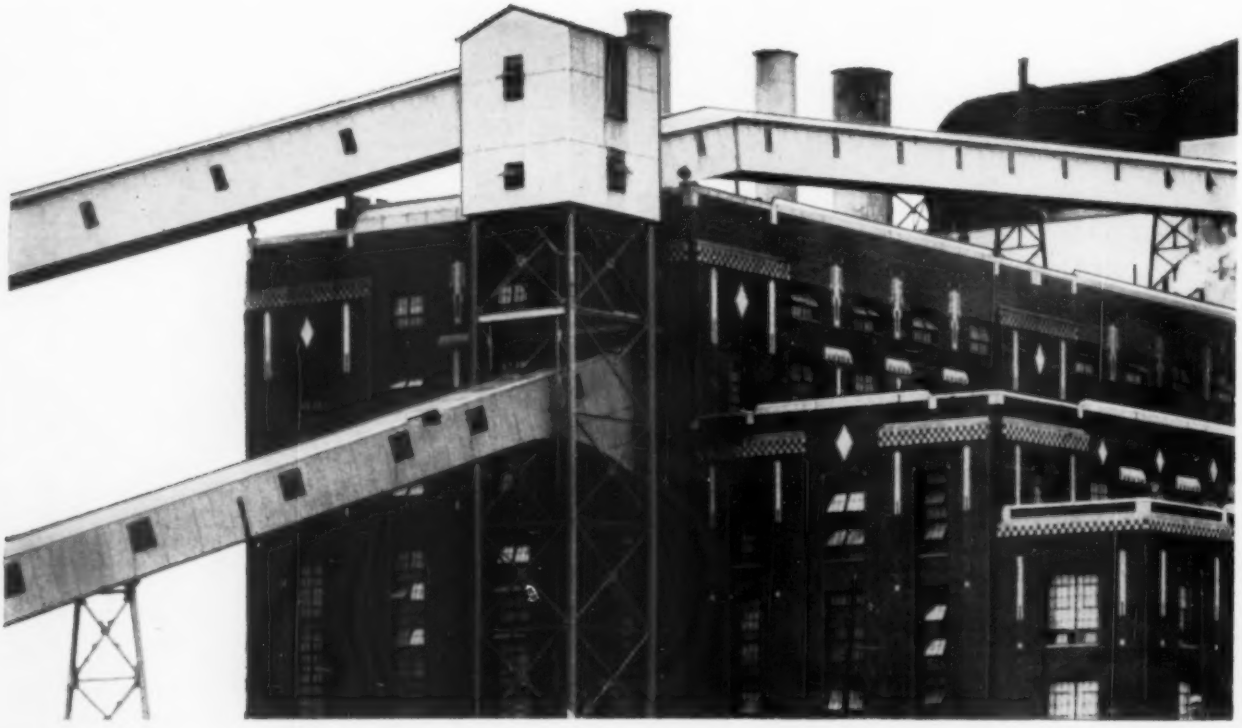
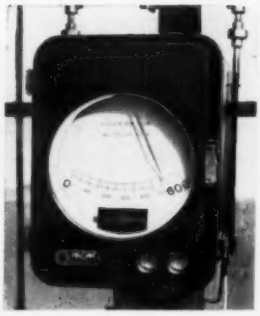
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED
OFFICES IN: MONTREAL, TORONTO, VANCOUVER, EDMONTON





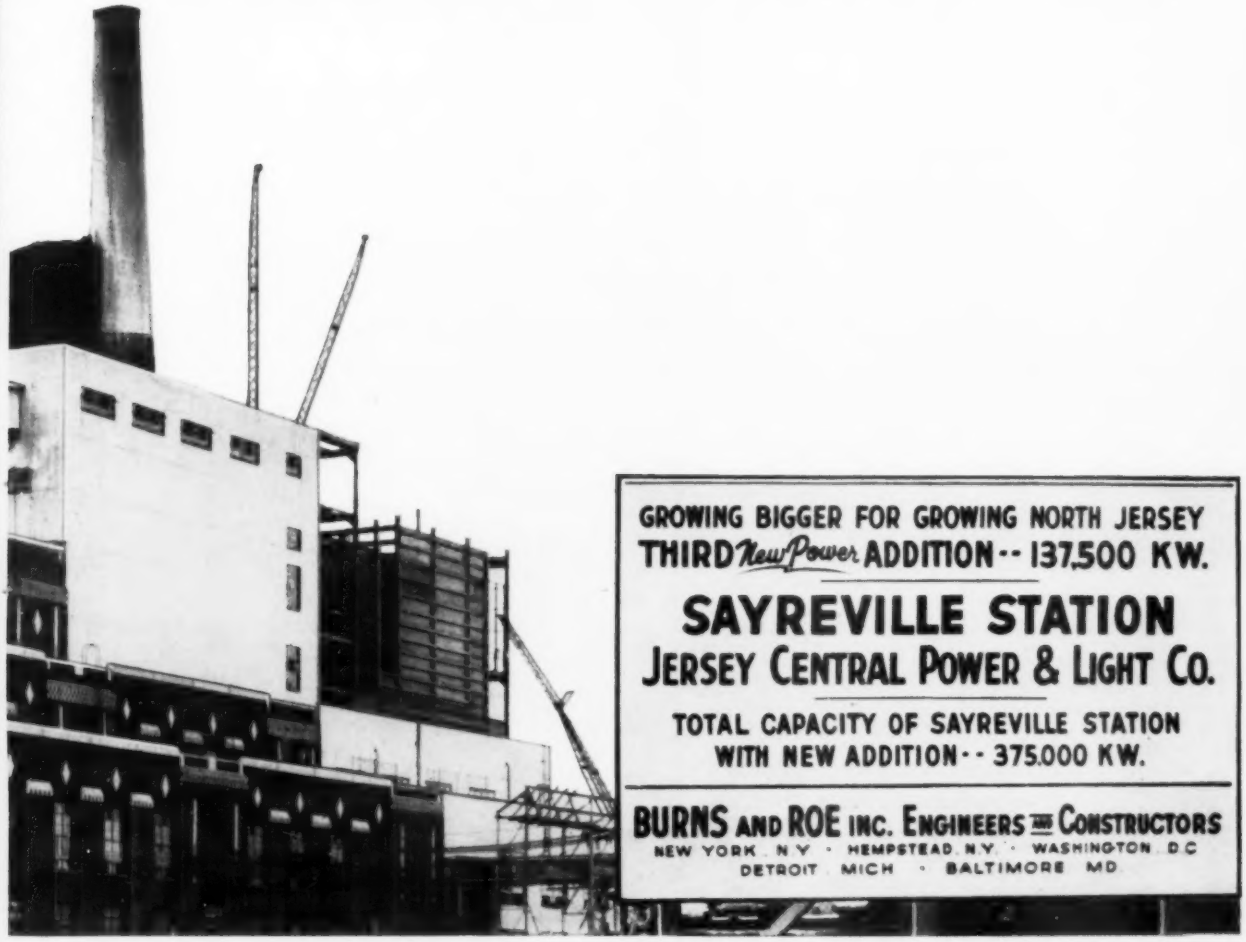
THREE-ELEMENT FEEDWATER CONTROL SYSTEM

Steam Flow Transmitter. The signal from this instrument is combined in a Hagan Ratio Totalizer with the signal from the Feedwater flow meter to hold these two variables in proper relationship during load changes. The inherent accuracy of the Hagan Ring Balance together with the unique spring resistance system permits easy range change, and more precise measurement of low flows.

Feedwater Transmitter. Feedwater flow is held in relation to Steam Flow, with final correction supplied by Drum Level. The combined signal is used to control feedwater pump speed. Jersey Central personnel like the ease with which the Hagan Ring Balance can be checked for calibration utilizing a dead weight system. The check is quick and can be made under full static pressure.

Drum Level Transmitter. The drum level instrument is automatically compensated for water density by a simple integral linkage which requires no external power source. The compensation insures a true measurement of this important variable. The signal from this instrument is transmitted to another Hagan Ratio Totalizer to provide control of level on a compensated basis.

Console and panel at the E. H. Werner Station. Centralized control conserves manpower and provides operator with a complete picture of station operation. The Ring Balance Instruments on the panel are recording all principal flows, pressures and levels.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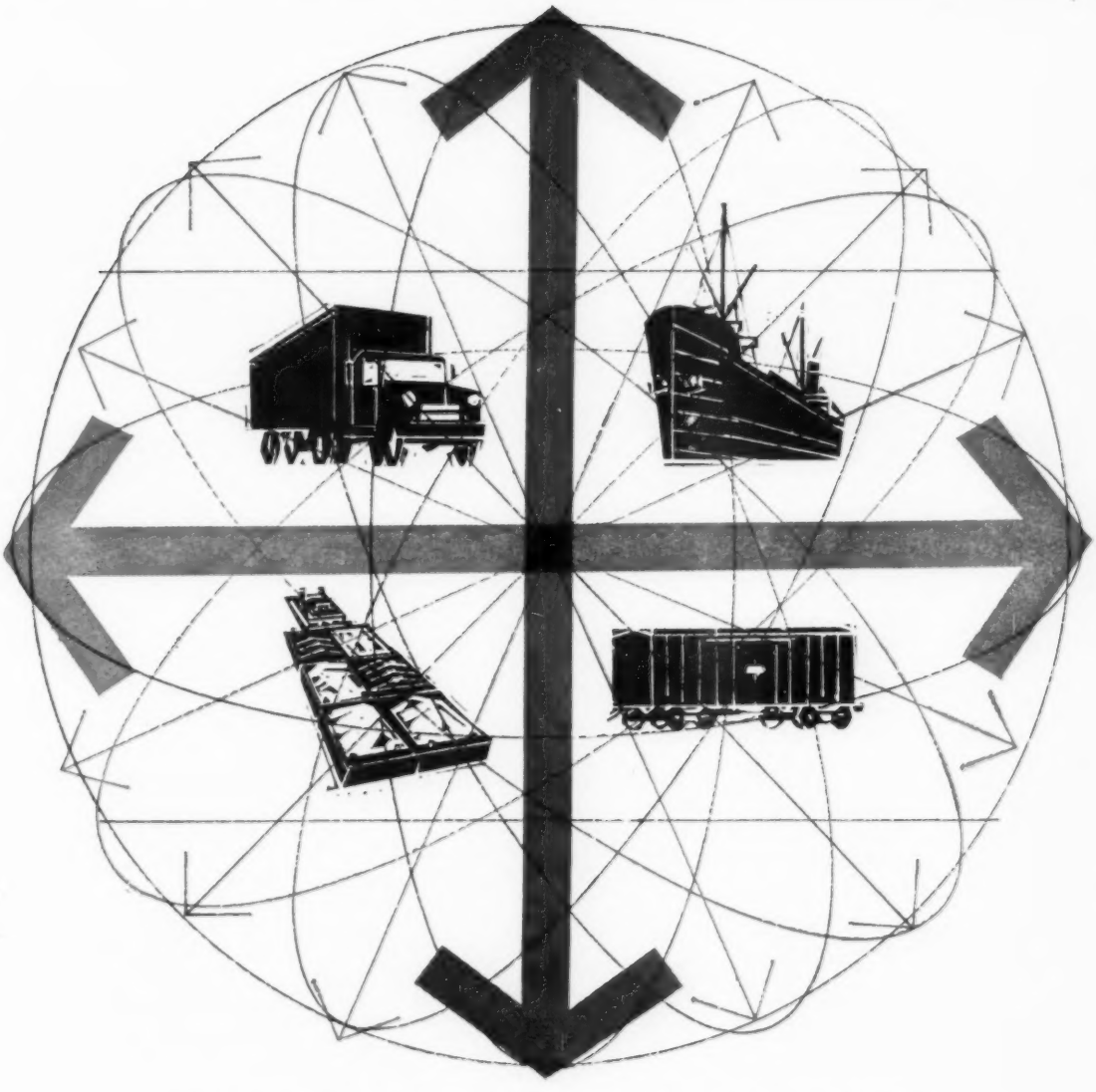

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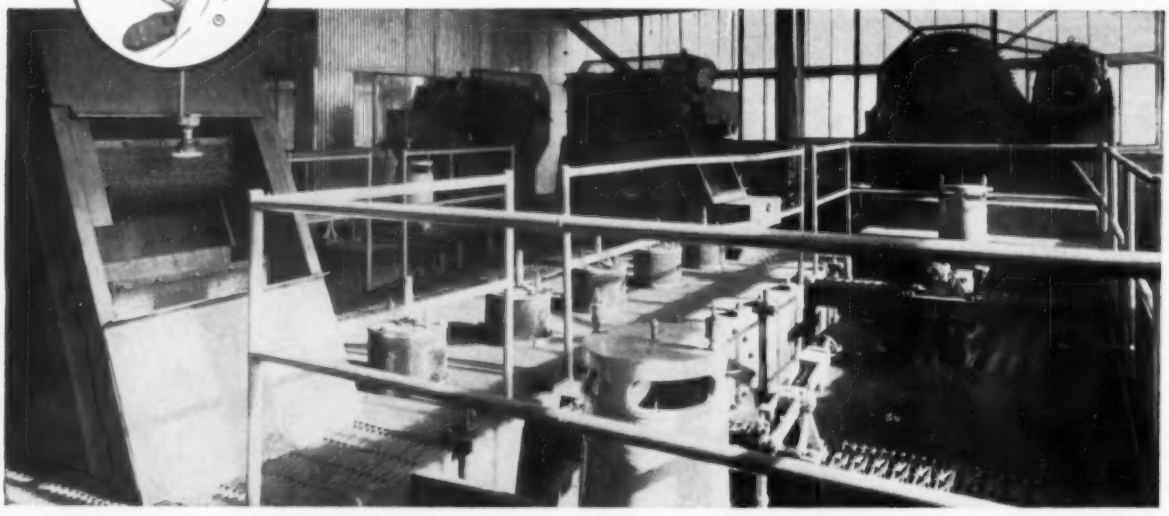

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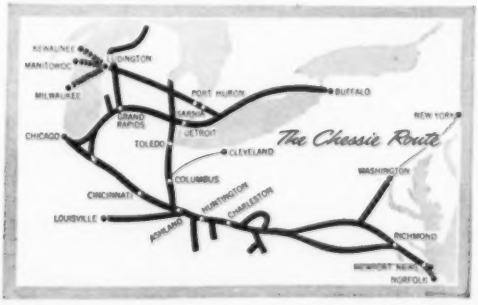

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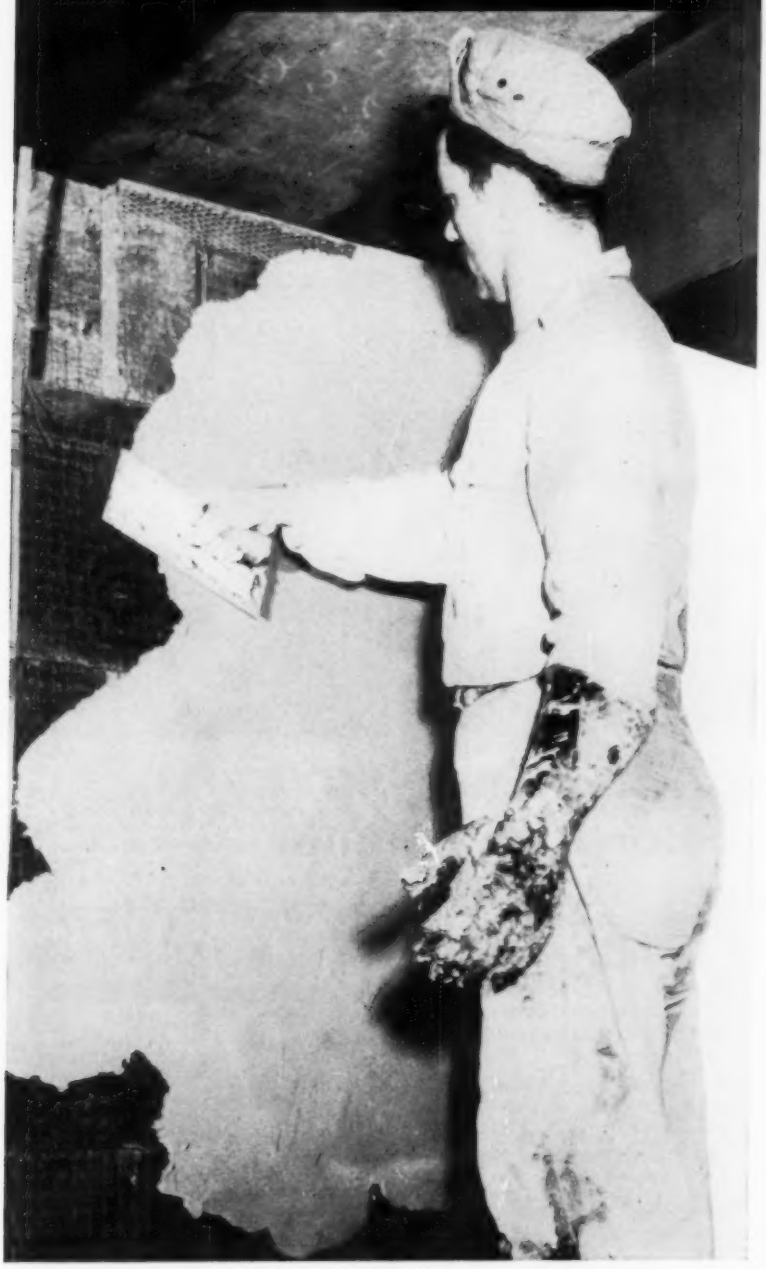

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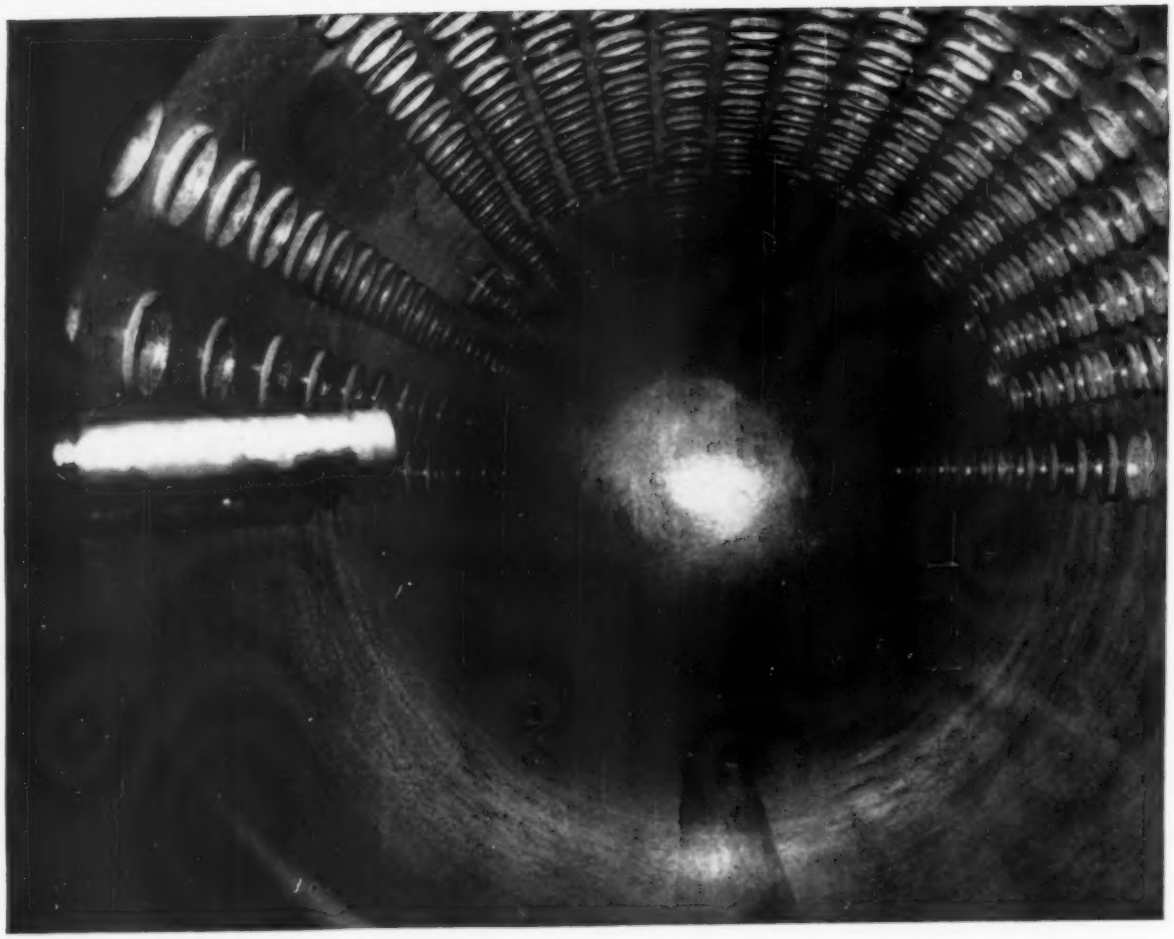

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HELPFUL BULLETINS

PIPING AND VALVES

101 Wrought Iron Pipe — This 8-pp booklet on wrought iron OD piping documents some 20 typical commercial and industrial installations. These case histories show wrought iron's durability under a variety of operating conditions. ASTM specifications under which the pipe is manufactured by this company are contained in booklet, as are photo-micrographs showing the physical structure of the material. A. M. Byers Co.

102 Pipe Joint Wrap — Featuring Duratape and Duramesh pipeline joint wraps, Form MDT-5 contains descriptions of physical and chemical properties of both coal tar and asphalt-impregnated glass fiber products. Also includes photos of typical hand wrap applications. L.O.F. Glass Fibers Co.

103 On Good Unions — "What Makes a Good Union?" is a 16-pp booklet of practical tips and information. Four fundamental qualities of a good union are described: pressure tightness, ease of installation, interchangeability and ability to withstand repeated makes and breaks. Other features highlighted are standardized design to recognized specifications; hardness differential between seats to prevent galling and damage. Clayton Mark & Co.

104 Swing Check Valves — Rubber-lined cushioned swing check valves for use in pulp and paper and in chemical industries are fully described in Bulletin W-11. General dimensions and parts list are included, along with specifications, installation and operation. Golden-Anderson Valve Specialty Co.

105 High Pressure Valve — Catalog Sheet 983 contains complete information, including photos and engineering drawings, on company's Type 505 high pressure control valve. Includes construction details, pressure and temperature ratings, sizing formulas for liquids or gases, other data. A. W. Cash Co.

106 Valve Sizing Data —Bulletin J-SC shows how to size company's sliding gate regulator valves. Technical data (applying to all makes of valves) tells how to adjust sizing for variations in pressure, temperature, viscosity, specific gravity. Charts cover steam, liquid and gas services. Cross-reference method of compiling utilized eliminates the need for rulers or for slide rules. Jordan Corp.

PACKINGS, GASKETS

107 Packings in Processing — "Chempac Helps Reduce Shutdowns in the Processing Industries," is a 16-pp illustrated booklet on Teflon and asbestos-Teflon packings and gaskets. Discusses improved performance and longer service against corrosives and solvents afforded by the Chempac line. Gives detailed information on molded packings, seals, envelope-type gaskets, sheets and tapes and miscellaneous shapes. Includes table showing manufacturer's other packings for processing industries. Johns-Manville.

108 Packing, Gaskets —Eight-pp Form 500 describes homogenous compressed asbestos sheet packing and gaskets. Lists 120 chemicals that can be handled by gaskets cut from this material. Also included are tables of stock sizes of sheets in five gages, and prices and dimensions of gaskets for cast-iron pipe flanges and flanged fittings and raised-face cast-steel flanges. Durabla Mfg. Co.

PUMPS, PUMPING

110 Twin Screw Pumps — Technical Bulletin 255 features twin screw pumps (Type TS) for non-corrosive liquids of wide viscosity range at pressures up to 350 psig and capacities to 550 gpm. Selection nomograph, outline dimensions, sectional drawing, and details of design and construction provided. Warren Pumps, Inc.

111 Axial, Mixed-Flow Pumps — Catalog G-100, 12 pp, describes axial and mixed flow vertical and horizontal pumps, designed to pump extremely large volumes of liquids at low to medium heads. Construction and design details, station arrangement suggestions and illustrations of a number of typical installations are included. Economy Pump Div., C. H. Wheeler Mfg. Co.

112 Centrifugal Pumps — Centrifugal pumps designed for continuous heavy-duty operation within the medium pressure range are described in 6-pp Form 7148-A. Cross-sectional views and a complete table of pump dimensions are included. Ingersoll-Rand Co.

113 Sump Pumps — Catalog E-101 describes company's non-clog sump pumps for drainage, underpass service, sewage disposal and other applications. Included are design and construction details, accessory photos and descriptions, and performance data. Cutaway drawing shows principal features. Economy Pump Div., C. H. Wheeler Mfg. Co.

114 Sealed Gear Pump — Technical Reference 57D describes a sealed gear pump for mounting on any machine which requires fluid circulation for lubrication or other purposes. Drawings illustrate internal mechanisms, and complete details on discharge rates, speeds, shaft connections, valves and other characteristics are given. Bijur Lubricating Corp.

BOILERS, HEAT EXCHANGERS

115 Automatic Boilers — Bulletin 1241, 6 pp, describes operation of a line of packaged automatic boilers designed for both air atomizing and pressure atomizing for oil burning and also for gas. Provides a chart listing ratings, dimensions, weights and approximate fuel consumption figures. Orr & Sembower, Inc.

116 Type BCF Exchanger — Eight-pp Bulletin 1.1K6 contains details of the recently expanded line of BCF Exchangers. Performance improvements and design features are fully detailed and complete specifications are included. Ross Heat Exchanger Div., American-Standard.

INSTRUMENTS AND CONTROLS

118 All-Purpose Controls — Simple controls, known as Versatrols and suitable for use with any detectable variable, are described in 12-pp Bulletin 106. Explains applications of the most common Versatrol circuits and includes tables of engineering data as well as photos and dimensional diagrams. Assembly Products, Inc.

119 Pneumatic Controllers — Twelve-pp Catalog 53P-4000 discusses motion-balance pneumatic controllers with regenerative feedback circuit. Covers controller response characteristics and includes cutaway drawings illustrating design and construction features, selection data, dimensions and specifications. Fischer & Porter Co.

120 Ring Balance Meters — Performance and specification data for series 3000 ring balance meters and accessories are presented in 8-pp Bulletin PM 10002. It contains descriptive text, tables and illustrations on such accessories as integrators, pneumatic transmitters, and pressure and temperature elements. Hagan Chemicals & Controls, Inc.

121 Precision Potentiometers — Catalog GR107, 28 pp, illustrates and describes a line of precision potentiometers. Electrical and mechanical specifications are included, as well as photos, diagrams and a section of general engineering data. George Rattray & Co.

122 Portable Potentiometer — Bulletin T-57, 6 pp, features the Thermotest portable potentiometer for measuring a wide range of temperatures and voltages. Lists 18 main uses for instrument and includes data on special features, scales and calibrations, circuit, and condensed specifications. Technique Associates, Inc.

123 Control of Levels — This 16-pp illustrated booklet describes in detail the measurement and control of level in industrial processes. Covers applications of capacitance-type devices in quantitative measurement and control of granular solids, liquids, powders and interface. Several industry uses are described. Instrument Div., Robertshaw-Fulton Controls Co.

124 Flow Colorimeter — Bulletin 4000 gives descriptions and specifications for company's standard flow colorimeter, and for a ratio recording flow colorimeter, instruments which continuously measure color intensity, turbidity, or chemical concentration in a wide variety of process streams. Beckman Instruments, Inc.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 127 and 128.

125 Speed Measurement Data — Available to power engineers is Brochure GET-2741 (1, 2, 3, 4) describing four methods of measuring speed to 0.01 per-

cent accuracy through use of company's Type HE potentiometer recorder. Included are four separate bulletins on application of the differential speed recorder; speed ratio recorder; speed deviation recorder; and multi-range expanded scale speed recorder. Other bulletins cover basic instrument: Bulletin GEC-1377 describes the potentiometer recorder, and Bulletin GEC-1258, the tachometer generator used with it. General Electric Co.

126 Millisecond Operations Recorder — Catalog 30A1400 describes company's Millisecond operations recorder for continuous automatic logging of power station operations. Specifications are given. Fischer & Porter Co.

127 Control Devices — Eight-pp Bulletin J-101 provides new information on company's Shaftrol and Valvetrol shaft-mounted positioning gearmotors for valves, drives, pumps and other applications. Specifications on a new Digital control system for machine tool positioning and for process control are presented. The Jordan Co., Inc.

128 Tube Expansion Control — Bulletin 64 describes a tube expansion control which automatically controls expansion by accurate measurement of torque. Advantages are detailed and specification data furnished. Airetool Mfg. Co.

WATER CONDITIONING

130 Boiler Water Treatment — This leaflet describes boiler operating troubles caused by impurities in feed water, and outlines procedure for minimizing damage to boilers and maintaining maximum efficiency. Subjects covered include hints on corrosion and scale prevention, tube failures, cast iron boilers and treatment of boiler water. Water Service Laboratories Inc.

131U Film-Type Amine — This bulletin describes advantages of Hagafilm, a filming type amine for controlling corrosion in steam condensate systems. Included are a schematic drawing showing critical points of Hagafilm protection in a condensate system, factual case histories, and description of corrosion test units and kits. Hagan Chemicals & Controls, Inc.

MECHANICAL POWER TRANSMISSION

132 Packaged Drives — Eight-pp Bulletin 20,000 describes packaged drives for equipment requiring adjustable or speed synchronization. These drives incorporate in one package the elements of adjustable voltage d-c drives: unit cabinet containing power conversion equipment and controls; one or more control stations, and drive motor or motors, if desired. Explains basic circuit and available modifications. Major components are pictured, as are typical applications. Clark Controller Co.

133 Improved Drive — The Harmonic drive is explained as to design and performance in this illustrated bulletin. Tells its use in transmitting rotary, linear or angular motion and notes a number of applications of the new drive. As described, it utilizes a controlled deflection wave for positive transmission of power and data. United Shoe Machinery Corp.

134 Standard Gear Sets — Sixteen-pp Bulletin 700-C describes worm gearing supplied in individually matched sets and providing high load-carrying capacity on small center distances. Contains specification drawings for all worms and gears, tool charts and horsepower ratings for special gearset combinations, backlash tolerances, lubrication data and service factors. Cone-Drive Gears Div., Michigan Tool Co.

135 Precision Gears — This 6-pp brochure provides information on precision gears, commercial gears, speed reducers and motorized reducers. Outlines ranges, sizes and types of gears available and illustrates actual production steps used in manufacturing. Grant Gear Works, Inc.

136 Bearing Units — Catalog BU-101-A, 12 pp, illustrates and describes a complete line of bearing units, consisting of pillow blocks, flange blocks and ball bearings. Advantages are detailed and specification tables, comparison charts, and dimensional diagrams of the units included. Browning Mfg. Co.

TUBING

137 Steel Tubing Weights — Simplified instructions for determining weights of square and rectangular steel tubing are featured in 12-pp booklet, "Weight Tables . . . Rounded Steel Tubing." A standard factor for converting round steel tubing weights to square or rectangulr tubing is given. Data is applicable to either welded or seamless steel tubing, and weights for average and minimum walls are listed. Revere Copper and Brass Inc.

138 Ferrous Metal Corrosion — Bulletin TR-548 is a 10-pp reprint of an article discussing the corrosion of ferrous-metal tubing in refinery service. The article deals with separate phases of ferrous metal corrosion in the refinery field. The Tubular Products Div., The Babcock & Wilcox Co.

ELECTRICAL

140 Synchronous Motors — Features and applications of company's large high-speed synchronous motors and the company services that go with them are described in 8-pp Bulletin GEA-6620. Photos illustrate designing and manufacturing facilities and large cutaway drawings give x-ray view of the horizontal and vertical motors of 1,500 hp and up. General Electric Co.

141 Weather-Protected Motors — Weather-protected motors with enclosures built to NEMA Type II standards to meet every requirement of outdoor service are described in Bulletin 05B7874C. Gives data on construction and mechanical features and includes a cutaway view showing these features. Allis-Chalmers Mfg. Co.

142 Protected Motors — A-c motors from 1 through 125 hp are described in Bulletin B-2506. Photos, drawings and text explain total protection and its importance to motor performance. Reliance Electric and Engineering Co.

143 Transformer Engineering — Bulletin 137 is a 12-pp engineering manual covering four series of dry-type distribution transformers. They include 3 to 10 kva, class H insulation; 15 to 112½ kva, class H insulation; 3 to 112½ kva, class B insulation (silicone impregnation); and 150 to 500 kva, class B insulation. Dimensional data and ratings provided. R. E. Uptegraff Mfg. Co.

144 On Transformers — Some of the research facilities for company's line of transformers along with their design and construction features are described in 20-pp Bulletin 61B6186C. Covered are power, unit substation, secondary network, industrial application, furnace, distribution, and instrument transformers. Allis-Chalmers Mfg. Co.

145 Power Regulators — Advantages of company's line of redesigned single-phase power regulators are described in Bulletin 21B6065D. Operation and construction features are detailed and complete specifications are included, along with photos, cutaway drawings, diagrams, and pictures of typical installations. Allis-Chalmers Mfg. Co.

146 Force Control Switches — This illustrated bulletin describes a complete line of force control switches, designed for controlling mechanical forces electrically. Lists specifications and includes dimensional diagrams. W. C. Dillon & Co., Inc.

147 Parallel-Plate Capacitors — Bulletin GEC-1482 discusses application of high-frequency parallel-plate capacitors in induction heaters where they are used in parallel resonant or tank circuits. Includes performance data on 12 separate ratings, outline drawings of dimensions, characteristic curve, and pertinent water cooling data. General Electric Co.

148 Capacitor Equipments — Eight-pp Bulletin GEA-6657 describes pole-top fixed capacitor equipments for distribution circuits. Lists ratings, weights, dimensions, and includes charts, diagrams and pictures. General Electric Co.

149 Solderless Wiring Devices — Bulletin 158, 8 pp, describes time-saving solderless terminals and connectors for crimping to wire extremities. Includes data tables to assist in selection of wiring devices for every wiring job requirement. Electrix Terminals & Connectors, Inc.

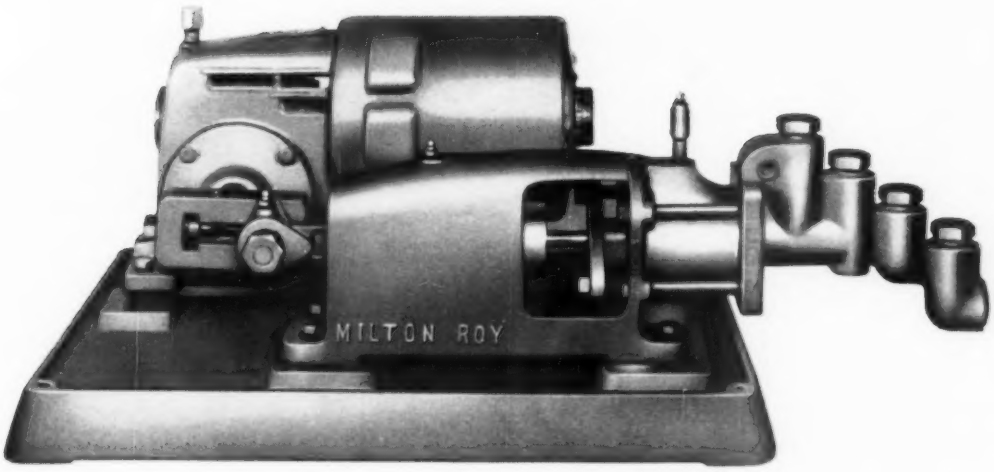
MATERIALS HANDLING

151 Handling Devices — Specific data on company's line of materials handling devices — clamps, drum lifters and tilters — is featured in 16-pp Catalog C-1. Contains product illustrations, application drawings, tables, diagrams, engineering data and other technical information on the equipment. Merrill Brothers.

Postage-free cards for ordering catalogs are on page 127. You may also use the cards to order literature mentioned in the ads.

152 Grit Handling Equipment — Book 2571, 28 pp, contains design data on grit collectors, washers and company's Tritor screen, a combination collector and mechanical screen. Essential equipment is shown for numerous applications and detailed drawings and specifications are included. Designs include velocity controlled chambers for shallow or deep chambers, those with dewatering and washing screws or inclined plane dewatering troughs. Link-Belt Co.

153 Car Dumper — Sixteen-pp illustrated Brochure 957 describes a rotary car



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Only ROTOJET Tube Cleaners offer the simple, efficient, time-tested Rotocentric design. A single paddle maintains contact with the cylinder wall without depending upon centrifugal force. Motor won't stall at low speeds caused by heavy loads. Positive starting is assured with Rotojet motors driven by air or steam.

Rotojet water-driven Tube Cleaners are comparable in speed and power with air-driven types.

Send for bulletin showing motors, heads, and brushes for straight and curved tubes and pipes from ⅛" to 12" I.D.

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Model C-525 ROTOJET Air-driven Motor with swing-frame head and universal coupling for 2¼" to 3½" I.D. curved tubes.

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Model C-526 ROTOJET Air-driven Motor with single pin head and universal coupling for 1¼" to 2½" I.D. curved tubes.

Model C-434 ROTOJET Junior Air-driven motor, flexible holder, expanding brush.

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Model C-322 ROTOJET Water-driven Motor with 3-arm head and universal coupling for 2¼" to 2½" I.D. curved tubes.

Model S-360 ROTOJET Water-driven Motor with combination drill head and universal coupling for 3¼" to 3⅞" I.D. straight tubes.

Model C-321 ROTOJET Water-driven Motor with short 4-arm head and universal coupling for 2½" to 3" I.D. curved tubes.

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dumper capable of handling hopper and gondola cars and equipped with clamps which hold the dumper car without counterweights. These and other design features are explained and illustrated, and several installations are pictured. Heyl & Patterson, Inc.

154 Tractor Maintenance — The primary purpose of this 24-pp maintenance guide is to supplement the more detailed information found in company's "Operation and Maintenance" books. The guide is filled with numerous drawings illustrating helpful service tips for track-type tractors. It tells how one machine owner improved performance and longevity of his tractor through good maintenance methods. Cartoons are used to emphasize these methods. Caterpillar Tractor Co.

155 Why Reconditioning — "Golden Opportunities" is an 8-pp booklet explaining this tractor manufacturer's services in returning owner's parts to useful service. Illustrates rebuilding of sprockets, idlers, track links, track roller rims and flanges, roller bushings etc. Other photos show methods used to restore fuel injection equipment, cylinder heads and liners, pistons. Caterpillar Tractor Co.

OTHER EQUIPMENT

156 Vibration Control Mountings — Bulletin K4D gives engineering specifications and performance data on 15 types of machinery mountings which utilize steel springs, rubber, and cord. Installation photos cover a variety of equipment. Also provided is a detailed discussion of relative merits of springs and organic materials as isolating media and conditions for best performance. The Korfund Co., Inc.

157 Vinyl Plastic Hose — This 8-pp catalog describes advantages of an industrial hose of specially compounded vinyl, designed specifically for pneumatic and hydraulic applications where working pressures up to 125 psi are encountered. Includes technical data, as well as illustrations of the various types of hose and fittings and pictures of typical applications. Hoffmann Engineering Co.

158 Steel Weld Caps — Folder WC-1 describes ellipsoidal steel weld caps for use in pipelines, headers, or pressure vessels. Complete specification and dimensional data given. Henry Vogt Machine Co.

159 Compressed Air Dryers — Catalog D1-957NE10, 12 pp, describes new models of heatless, self-activating, zero-dewpoint dryers designed to prevent moisture fouling of instruments, lubrication, controls, testers, circuits, chemicals, gases, finishes, compounds, and solutions. Van Products Co.

160 Thermostat Metals — "Corrosion-Resistant Metals," summarizes test results on various thermostat metals exposed to corrosive environments such as highly humid atmospheres, hot water, salt spray, etc., and describes the material as observed in actual use. Includes relative cost chart, a comparative thermal deflection graph, and a listing of mechanical and physical properties for eight thermostat metals. General Plate Div., Metals & Controls Corp.

161 Meter Houses — Twelve-pp Catalog 10 gives specifications and construction features of weatherproof meter houses, including standard, multi-door, horizontal, portable walk-in, utility, indi-

POWELL

world's largest family of valves

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 W.S.P. Spur Gear operated. Can be furnished with bevel gears.

Fig. 6003 WE—Steel O.S. & Y. Welding End Gate Valve for high pressure service—600 W.S.P. Steel valves are available for pressure from 150 to 2500 W.S.P.

Fig. 1793—Iron Body Bronze Mounted O.S.&Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061 WE—Steel Welding End Swing Check Valve for 300 W.S.P. No obstruction to flow through when wide open.

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 125023—Large Steel Pressure Seal Gate Valve for 2500 W.S.P. Equipped with Electric Motor for operation by remote control. Steel Pressure Seal Valves can be furnished for pressures from 600 through 2500 pounds.

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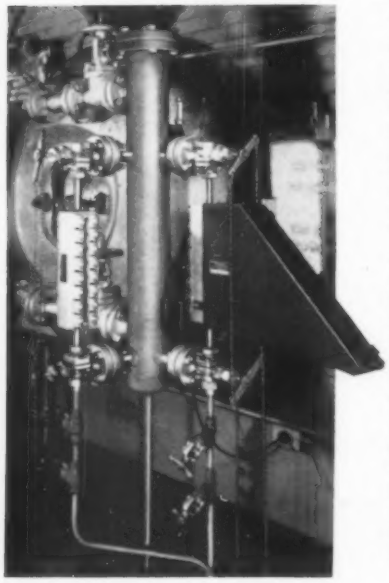
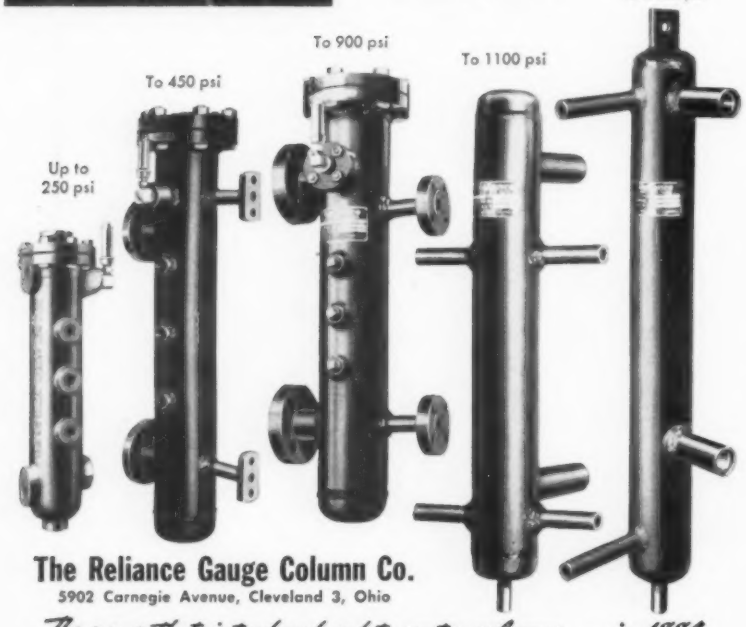
Insure safe, continuous boiler operation with **Reliance** Water Columns



Water columns have been around for a long time — ever since Reliance introduced the first one in 1884. Its chief reason for existence then was to carry the float-operated whistle alarm and mechanism, to warn operators of dangerously low water in the boiler. Since then, the water column has been developed in various styles and capacities to meet any power plant need. They are used on most boilers today as an accepted necessity, although many old time engineers — and thousands of young ones — can't explain their full usefulness. If you'd like to know "why a water column", write for free copy of our Liquid Level Letter No. 11.

Reliance makes Water Columns in seven pressure categories, five of which are represented below. And complete "trim" — gage cocks, gage valves, gage inserts, special gages and direct-to-drum assemblies. Write for information on equipment suited to your working pressure.



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eating or recording types, as well as vertical plant, custom built and cycling meter houses. Illustrated with photos and diagrams, catalog includes installation details. Moran Furnace and Sheet Metal Co.

162 For Big, Little Bends — For those interested in bending of pipe, tubing or structural shapes, this 36-pp brochure illustrates the various types of bending and their applications. Utilizes in-plant pictures to show rotary, ram and roll bending and the equipment used for each. Wallace Supplies Mfg. Co.

163 Air and Steam Cleaners — Bulletin 502 describes filter-free, maintenance-free air cleaners and steam cleaners manufactured by the company. Selection tables, specifications, and other technical data included. The V. D. Anderson Co.

. . . Outstanding Among This Month's Catalogs

164 Low Voltage Switchgear — Major operating and maintenance innovations in company's line of low-voltage switchgear are detailed in 20-pp Bulletin 6004-C. Application tables provide complete breaker ratings, control-power requirements and ranges of over-current trip devices. Basic information and selection data are included, as well as dimensions, a sample specification form, and a diagram and graph to explain short-circuit currents. I-T-E Circuit Breaker Co.

165 Combustion Gas Turbines — Versatility in application of the combustion gas turbine in gas transmission, petrochemical, petroleum, chemical, rubber and paper industries is described in Publication GED-3546, 32 pp. Data pertains to these prime movers from 6700- to 30400-hp and 4750- to 21800-kw in capacity. Points out availability of shaft power, exhaust heat and hot air or gas obtainable from the combustion gas turbine which also operates on other fuels. Five possible operation cycles are shown. General Electric Co.

166 Copper and Corrosion — — Publication B-36R is a revised edition of Corrosion Resistance of Copper and Copper Alloys," a 32-pp reference booklet. Latest findings are incorporated in the text of Part I, on theory of corrosion and types of corrosive attack. Booklet includes general discussion of corrosion resistance of copper and copper alloys, list of typical uses of copper and its alloys, other information. A tabulation indicates relative corrosion resistance of the principal types of copper and copper base alloys when in contact with 186 corroding agents. The American Brass Co.

167 Boiler Control System — Bulletin 1038, 12 pp, describes complete boiler control systems available for large utility power stations. Using a 900,000-lb-per-hr installation as an example, it gives a detailed description of each component, combustion, fuel cutback, pulverizer temperature, feedwater, and feed pump recirculation controls, as well as automatic-sequential soot blowing system. Schematic diagrams of systems are included. Copes-Vulcan Div., Blaw-Knox Co.

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TRACERS

Power Engineering's Monthly Probe of Power Facts

First it was the vacuum tube, then the transistor which was the principal dynamic element in electronic circuits. Now there's a third possibility — the *solion*, a new name for an old phenomenon. In the solion, ions in solution carry the charge. Based on both electrochemical and fluid flow principles, the solion is very sensitive and its low power requirements make it ideal for remote and unattended devices. It is especially efficient at frequencies below one-tenth of a cycle per second. In many applications it is expected that the solion will replace a complicated circuit of resistors, capacitors, inductances, and electron tubes or transistors. Commercial development of the solion is being carried on jointly by National Carbon Co and Texas Research Associates.

Eastman Kodak Company's establishment at Rochester, N. Y., is using a cyclone furnace boiler, one of the first industrial applications of this type of boiler. The boiler utilizes two huge, 1000-hp fans to provide air for "cyclone" firing of the coal that builds operating steam pressures up to 1400 psi. Novel feature of the installation is an extra system that returns the ash dust from the burned coal to the cyclone furnace. The recovered dust is converted to slag so that it can be disposed of without spreading dirt and dust.

Evaporator or demineralizer — which should it be? In this issue, Partridge and Osborne continue the careful analysis they began last month on the relative advantages of these two comparable methods. Make-up of adequate purity can be prepared by either method for any boiler now being designed for service, but these experts expect to see the spotlight on evaporators during the immediate future. Why? Turn to page 66.

New, highly corrosion-resistant pipe which will give all the benefits of solid stainless at lower cost, and in diameters as small as 4 in., has been announced by Lukens Steel Co. Inside surface is a layer of stainless steel which is completely and permanently bonded to a heavier outer layer of carbon steel. Of interest especially to the nuclear, chemical, petrochemical and petroleum industries.

High tensile bolts used instead of rivets will cut costs of power plant construction. Houston Lighting and Power Co used this method at its new Smithers Lake station, cut labor costs on fastener installations 63 per cent. Fastener costs over-all were cut 18 per cent. The article on page 90 of this issue describes the Houston experience in detail.

What actually happened at Windscale in England when the plutonium plant there spread radioactive contamination over the countryside? Probing into the causes and meaning of this serious accident, ATOMICS Editor Andrew W. Kramer has piece together the dramatic story of what happens when fire occurs in the uranium of an atomic pile. It's in the special section of this issue, page 45.

which is the better buy — Evaporator or Demineralizer?

NO EASY ANSWER

A major responsibility of the engineer is to get things done at the lowest cost. The cost he must consider, however, is the total cost stretching on into a future he often cannot predict with any inner feeling of certainty. If he were to reassure himself by spending $25,000 to obtain the answer to a $10,000 question, no one would applaud his caution. Accordingly, he goes as far as he can on facts, then with his eyes and ears wide open, seeks informed opinions before he reaches a decision.

The authors of this article, continuing a discussion they began last month on evaporators and demineralizers (POWER ENGINEERING, January, pages 84–85), believe it to be a fact that make-up of adequate purity for any boilers now being designed for service can be prepared by either evaporation or demineralization.

It is their opinion that an evaporator can be made inherently more foolproof than a demineralizer without increasing the cost to a non-competitive level. They look forward to increased activity in the development of evaporators and in the more precise determination of their capabilities.

Demineralization will not, however, stand still. Partridge and Osborne confidently expect further improvement in exchange resins and in the engineering of their use which will minimize the twin bogeys of chemical deterioration of the resin itself and loss of capacity due to fouling by some constituent of the water being treated.

For at least another decade, in their opinion, this anticipated progress will require that the engineer calculate costs and weigh intangibles for each projected new unit. There will be no easy handbook answers.

By EVERETT P. PARTRIDGE and S. R. OSBORNE *

ECONOMIC evaluation of the two methods of providing feedwater for steam generators must consider such major factors as fixed charges on capital invested and cost of fuel and chemicals. We should not, however, arrive at a final answer without duly weighing intangible bonuses and possible penalties inherent in each process. Both the straightforward economic analysis and the weighing of this for intangibles may well differ if two units are being installed instead of one, or if an additional unit is being considered for a plant in service.

Several plant variables must be pin-pointed before the economic study can proceed: 1. maximum and average make-up demands; 2. reserve capacity required in the make-up system to accommodate maintenance outages; 3. analyses and availabilities of raw water sources; 4. fuel cost, future as well as present; 5. the projected plant heat balance.

Evaporation Costs

Fixed charges on installed investment will generally be the highest of the annual costs ascribable to evaporation. The over-all investment figure should encompass not only the installed cost of the evaporator system proper but the capital tied up in the raw water pretreating equipment, prorated in case treated raw water is used elsewhere in the plant.

Each electric utility seems to have an individual method for figuring the annual charges against capital investment. These will normally include gross earnings to provide a certain percentage net return on investment, plus Federal income and local taxes and depreciation. On summation such items will generally constitute an annual charge of 13 to 15 per cent against the gross capitalization.

Degradation of cycle heat rate and how such should be fairly charged against evaporator operation is beyond the scope of this article.[1,2] It is noteworthy, however, that nine years ago when demineralization was just getting a toe-hold in the utility field some engineers steadfastly maintained that evaporators should be debited not only for differential in fuel cost but for a phantom turbine capacity charge as well. The consensus nowadays is that the latter is not a valid operating charge.

On examining influence of evaporator position in the heat cycle, care must be taken not to overlook the heat loss in evaporator blowdown. Also, the evaporator may be used as a flash tank for the boiler blowdown with savings in heat and make-up.

Other annual charges applicable to evaporation include:

1. *Chemicals* used in pretreatment of the raw water and/or conditioning of the evaporator brine. Such cost may be essentially nil in areas where the raw water is immediately suitable for evaporation; at plants with poor raw water it may amount to 15 cents or more per 1000 gallons of make-up delivered.

2. *Basic maintenance.* The annual charge for inspection, cleaning and repair of water pretreating components, evaporators and allied equipment is generally taken at 1 per cent of the gross installed investment.

3. *Operating labor.* In most cases this will be principally the labor required at the treatment plant. Evaporators characteristically have required relatively little direct supervision; vapor purity monitoring by conductivity and periodic checking on the brine for alkalinity, solids and also phosphate where internal conditioning is used, represent about all the chemical control that has been needed. More control, perhaps with the sodium tracer method, may be needed to guarantee ultra-purity.

4. *As-received cost* of the raw water plus pumping energy expended in moving it through the make-up system to the evaporator.

Demineralization Costs

The current trend in design of demineralization systems for production of ultra-pure make-up water is toward one of the following:

I. Mixed bed (regenerant water softened by sodium zeolite).
II. Primary cation → (Vacuum deaeration) → Mixed bed.
III. Primary cation → (Vacuum deaeration) → Primary anion → Mixed bed.
IV. Primary cation → (Vacuum deaeration) → Primary anion → Secondary cation → Secondary anion.

It is not our purpose here to discuss

* Both of the Hall Laboratories, Inc. Pittsburgh, Penna. This article and the one by the same authors, published in the January issue, were condensed from a paper presented to the Prime Movers Committee of the Pennsylvania Electric Association in October, 1956.

the advantages and disadvantages of unit arrangements for demineralizing processes; this has been amply done elsewhere.[3] We would like to emphasize, however, that selection of the most applicable demineralization scheme for a particular plant is a job which often challenges the wits of even the most experienced water specialist. It is an area where an engineer not abreast of the latest developments in the field may lose course quickly and find himself adrift in a sea of claims and counterclaims, each tendered in utmost sincerity by competing equipment bidders.

Having once settled on the preferred demineralization system via economic comparison of the possible schemes, calculation of the annual costs for the process chosen is rather straightforward. It generally follows the pattern previously established for evaporation.

Annual Cost Factors

1. A demineralizer setup often, though not necessarily, represents fewer dollars in installed investment. This depends a lot on how elaborate the pretreatment must be to minimize trouble in operation of the ion exchange beds. For example, an increasingly common pretreatment arrangement for a water known or suspected to be capable of fouling exchange resins provides for breakpoint chlorination and activated carbon treatment in addition to the usual clarification/softening and anthracite filtration. This same water might only require simple filtration prior to evaporation.

Other investment expense factors which frequently escape proper evaluation are: remote location for a demineralizer — "out of the high rent district"; possible reduction in investment for condensate and surge storage capacity; provision for bulk storage of acid and caustic; facilities for disposal of the waste regenerant solutions.

2. Since demineralized make-up is generally added at the hot well there exists a common misconception that this has no adverse effect on cycle heat rate. The fallacy in such thinking has been fully explored by Morris and Brune.[1]

3. Chemical operating costs for demineralizers are usually modest for most medium and low solids waters. However, for high solids or otherwise "raunchy" supplies, over-all chemical costs incident to production of demineralized make-up may easily exceed similar costs for evaporator operation. A very rough rule-of-thumb as to the break-even point between these chemical costs can be stated at 300 ppm of dissolved solids in the raw water.

4. It is customary to levy a basic maintenance charge of about 2 per cent per annum against the installed cost of demineralization systems. But an even higher maintenance expense is often involved in resin replacement. For the polystyrene cation material usually employed, a 5 per cent yearly replacement of the bed volume should be quite ample, although a few cases of relatively rapid loss in capacity are known. When it comes to estimating replacement of the strongly basic anion resin the only safe guide is previous experience with demineralizing the specific water supply involved. In the absence of such information an estimated replacement schedule of every three to five years for the anion resin might not be out of line.

5. A demineralization plant is apt to require more supervision than an evaporator system of equal capacity. A surprisingly large spread exists, however, as to labor costs between plants with equivalent demineralizer systems. Some prefer to have the demineralizer under more or less constant supervision while others have pretty well robotized the operation.[4] One plant[5] after a year's experience with automatic demineralization concluded that they would not install automatic controls on units of less than 100 gpm capacity.

6. One factor often overlooked in figuring the cost of total water supplied to the demineralizer is that much of it is lost during regeneration. This is particularly true when the solids content of the influent water attains the range of 300–500 ppm. To illustrate, we recently studied the application of a 3-bed demineralizer system with interstage degasification to a water supply containing 500 ppm solids; for each 100 gallons net output the waste water would amount to about 60 gallons.

Comparison of Costs

Simple summation of the individual annual costs for each method of preparing the make-up is now in order. Should the comparative economics overwhelmingly favor one method, then the question of which system to buy is answered. On the other hand, should the economic studies terminate in pretty much of a standoff between evaporation and demineralization, we must lay aside our charts, tables and slide rules and focus our attention on the intangibles thus far kept in the background.

Evaluation of Intangibles

Not so many years ago evaporators enjoyed a wide margin of favor over demineralizers on the basis of ease of operation and consequent requirement of less "know-how" from the operators. Although still perhaps correctly considered as the more conventional process, evaporation has been losing this early advantage as more has been learned about the vagaries of demineralization. Should this trend continue, as now appears likely, evaporation will steadily lose its "more familiar" label. However, it does seem destined to remain the more simple method because demineralization, at least at the present stage, is much more complex, both process- and equipment-wise.

Some utility men, particularly those in the operating group, express concern over the potential hazards of demineralizer operation. Not only do they worry about someone getting doused with strong acid or caustic solution but they are afraid that through misoperation, human or mechanical, a slug of acid or shot of caustic will wind up in the boiler, damaging it and/or the turbine it serves.

Aside from the damage proper, such an outage could be quite expensive if the plant were accordingly forced to purchase power. For example, the incremental cost to replace a lost capacity of 100 megawatts average is on the order of $5000 per day. Other things being equal, operating errors with evaporators are obviously much less hazardous.

Purity and Demineralizers

Demineralizers must operate more or less continuously if they are to deliver a top purity effluent. After lying idle for a while, even mixed-bed units require a short rinse to waste before they again produce highest quality water. This leaching of ions following an idle period is still more pronounced in multi-bed system; a in fact, a multi-bed plant not equipped with a "scavenging" unit (mixed-bed or secondary cation-anion pair) will not operate at all satisfactorily at a through-put rate under about 20 per cent of design.

The prime advantage which a demineralizer has over an evaporator is that its output is geared neither volume-wise, nor purity-wise to the turbine load. At no time is a demineralizer appreciated more than when starting up a new boiler where there is no condensate available. A demineralizer can also be operated for limited periods at well above normal rating when the need arises; for example, when refilling a boiler after an outage. Such flexibility has obvious merit from an operating viewpoint in addition to the dollar savings in condensate and drip/drain storage that must be reckoned with in the economic study.

How much value should be assigned to such intangible factors might well be the subject for many hours of testimony from actual experience.

THE END

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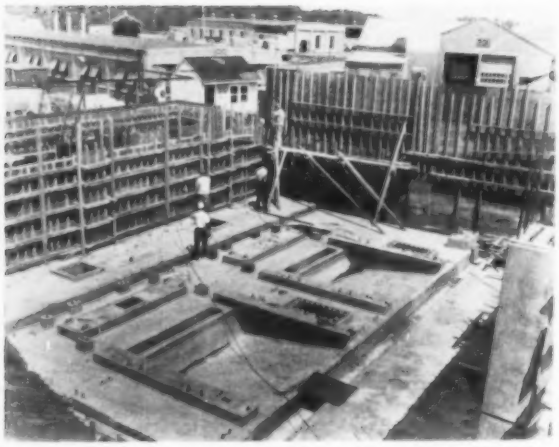


Fig. 1. First stage of new plant. Square openings, rear, are for forced draft intake; trenches, for ash removal, piping

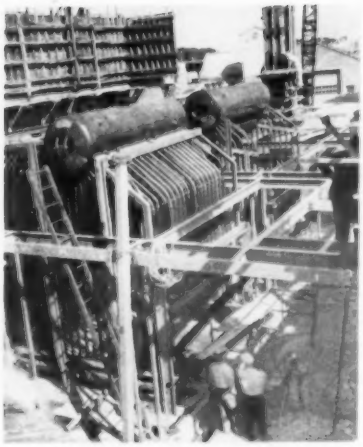


Fig. 2. To save time, boilers go up while work on building progresses

How and Why This Heating Plant

By DENARD L. GUSLER

URGENT NEED for a new steam heating plant for the U. S. Naval Ammunition Depot at St. Juliens Creek, Portsmouth, Va., was brought to the attention of Naval authorities in July, 1954.

At that time, the existing facilities included two steam plants. The main plant was housed in a wood frame and sheet metal building constructed in 1931, and now in dilapidated condition. The wooden roof trusses created considerable congestion resulting in limited head room above the boilers. Wooden members were close to the stacks and created a fire hazard. Boiler foundation was eroded and cracked, and was settling, causing serious stresses.

The plant had seven boilers, of two different types, equipped with radiant-wall furnaces and fired with Navy special bunker oil through mechanical atomizing burners. Boiler installations dated back to 1931 and 1942. Vertical stacks of metal construction were mounted on and at the front of each boiler, and guyed to concrete anchor blocks.

Fuel oil was stored in tanks located above ground adjacent to the plant building. The oil heating and pumping installation was the conventional type. Oil flow to the burners was regulated manually, and was not metered. Instrumentation for steam, water and oil flow measurement and control was not provided.

Feedwater to the boilers was provided through three Elgin water softeners having a capacity of 700,000 grains from the station mains to a condensate return tank. Condensate from the industrial area was returned through a pumped condensate return system. The mixed condensate and soft water were pumped to a deaerating heater having a capacity of 60,000 lb per hour through boiler feed pumps to the boilers. The flow of water to the boilers was regulated manually.

Daily tests were made of the boiler feedwater. Caustic soda, sodium sulfide, and phosphate were fed to the boilers by a reciprocating steam pump, from a solution tank as necessary. This arrangement was regulated manually.

Consumption of raw water at the plant prior to the installation of a condensate return system in the industrial area was estimated to be 13,700,000 gal. yearly, which was purchased from the City of Portsmouth. After installation of the condensate return system the estimated consumption was 6,850,000 gal.

A railroad trestle was located immediately outside the boiler plant for the purpose of delivering coal as an auxiliary fuel. No mechanical provision existed for handling and firing.

A standby steam plant was located in a key industrial area. This plant included two boilers, was constructed in 1942.

Problem in Maintenance

The existing steam heating plants thus comprised a total of nine boilers of different makes and types that were inefficient and required considerable maintenance. Yearly operating labor costs were excessive.

The number and variety of the installed boilers entailed a considerable inventory in the quantity of spare parts required for maintenance. The refractory furnaces were continually in need of repair. A recommendation had been made that the boilers in the standby plant be retubed as soon as practicable. Material and labor costs of repair and maintenance were commensurate with the age of the plant.

Besides manual operation, refractory furnaces, and intermittent firing, the over-all efficiency was approximately 60 per cent or less.

Engineering studies indicated that a centralized operation utilizing modern water-wall furnaces, automatic combustion control, and proper metering devices would result in an increased efficiency of up to 20 per cent and a considerable saving in fuel.

Estimated steam load as determined by field survey was as follows:

Heating Steam Load	17,449	
Process Steam Load (75% Load Factor)	7,670	
	25,119	
Line Loss	2,510	
Total	27,629	
Add 25% for Future	6,750	
Line Loss	675	
Total	35,054	
Feedwater Heating (Emergency 100% Raw Water Make-Up)	6,400	
Oil Heating	200	
Oil Atomizing	250	
Total Steam Load	41,904	lb/hr

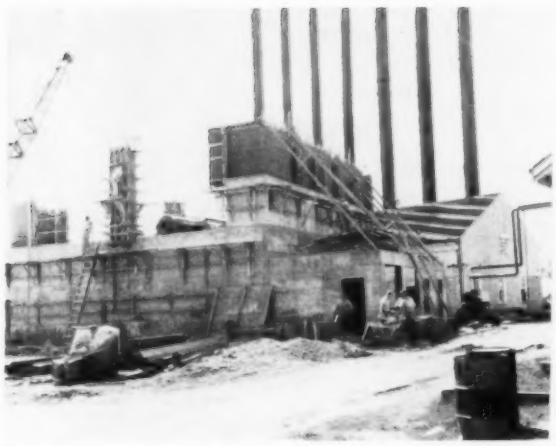


Fig. 3. Old plant with its 7 stacks is seen immediately adjoining the new building. New construction is heavy concrete

Fig. 4. Almost completed, new plant is 30 ft high, encloses 69,000 cu ft in main section for boilers and their operation

Went Modern

Official U. S. Navy photographs

Fig. 5. St. Juliens Creek heating plant, completed. Steam distribution and condensate return are run overhead on steel pipe supports

It was decided that a minimum replacement facility would comprise two modern water-tube steam generating units having a capacity of 34,000 lb of steam per hour each.

Total yearly estimated saving was figured at $44,820.

New Plant Was the Answer

Based on the foregoing existing facilities, operations, and steam loads, the engineering studies made the recommendation to build a modern steam generating plant, whose mechanical equipment would include:

1. Two multiple drum, water-tube boilers, complete with integrally mounted burners and all necessary appurtenances for automatic firing of Navy special fuel oil; each boiler to be rated at 34,000 lb of steam per hour and designed for future installation of stokers for firing coal.
2. A completely automatic, metered, oil pumping and heating unit.
3. An automatic chemical proportioning and feeding system.
4. A continuous blow-down system for control of dissolved solids.
5. A diesel-electric standby unit, transformer stations, for light and power with all arrangements necessary to ensure continuity of operation.
6. Existing equipment in existing main heating plant to be utilized as follows: water softeners, to be converted to completely automatic operation; deaerating heater; condensate return tank and pump.

Proposed project would provide for the future installation of a coal storage and transport facility, including firing arrangements; a pneumatic ash-handling facility; and a package-type oil-fired boiler for summer operation.

The new central heating plant that was built to meet the need (Fig. 5) has a boiler room and platform dimensions of approximately 46 by 50 ft comprising 2300 sq ft including exterior walls. Including the roof, the building height is approximately 30 ft, comprising 69,000 cu ft to contain boilers and related equipment.

A shop, transformer room, diesel-electric unit room, toilet, and office are provided in an area approximately 66 by 16 ft, comprising 1056 sq ft including exterior walls. Including the roof, this portion of the building is approximately 10 ft high, comprising 10,560 cubic feet.

First stage of construction is shown in Fig. 1. The two square forced draft intake openings are shown, upper left center, connecting to under-floor concrete ducts. Immediately in front of the forced draft intake openings is a floor trench for boiler blow-down piping.

Trench shown at bottom of Fig. 1 will accommodate the future pneumatic ash removal system. Adjacent to this trench are the ash pits, to be located directly under the boiler grates. At the rear of the ash pits is a long rectangular opening connecting to the forced draft air duct system to provide combustion air for the future boiler stokers.

Parallel to each ash pit is a small rectangular opening connecting to the forced draft air duct system to

Inside the new central heating plant at St. Juliens Creek

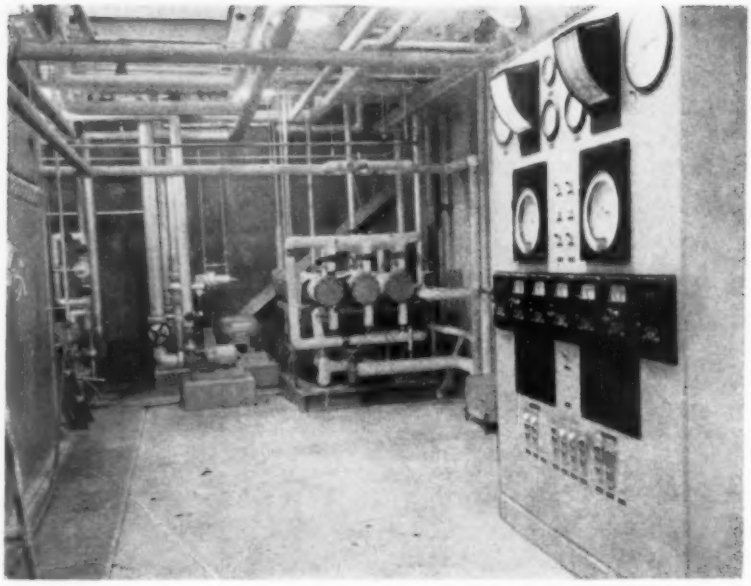


Fig. 6. Firing aisle details: combustion control panel, right. At rear, oil pumping and heating set, with 3 heat exchangers, 3 oil pumps, condensate pump, electric-driven boiler feed pump

provide air to the plenum chamber of the oil burners. Connections to each duct opening are each furnished with a manual damper to permit transfer from coal to oil firing or vice versa.

Installation of the boilers is shown in Fig. 2. Steel for the operating platform is in place, and one boiler has been blanked off for hydrostatic test. The operating platform steel is supported independently from the boiler supporting steel.

At the rear of Fig. 6 is shown the oil pumping and heating set with three heat exchangers, two electric motor-driven oil pumps and one steam-driven reciprocating oil pump exhausting to atmosphere.

Oil pumping and heating set is designed for ultimate plant growth and will furnish the required amount of oil with any one pump and heat exchanger down for maintenance. Oil is preheated and pumped from the old existing tank heaters and oil storage tanks.

Adjacent to the oil pumping and heating set is shown a close-coupled condensate pump taking suction from a condensate tank located on the operating platform and pumping to the deaerator. At the rear of the condensate pump is an electric-driven boiler feed pump located adjacent to the steam turbine-driven boiler feed pump.

Each boiler feed pump takes suction from the deaerator and pumps to the feedwater regulators on the boilers. Either pump can furnish the feedwater requirement for both boilers. A bypass valve is provided so that the boiler feed pumps can take suction directly from the condensate tank in the event of emergency. The high-low-normal indicators on the combustion control panel are coupled with an audible alarm to warn the operator in the event of low water in either the condensate tank or the deaerator. Piping and grating have been painted aluminum color for maximum visibility. Later on, piping will be color-coded.

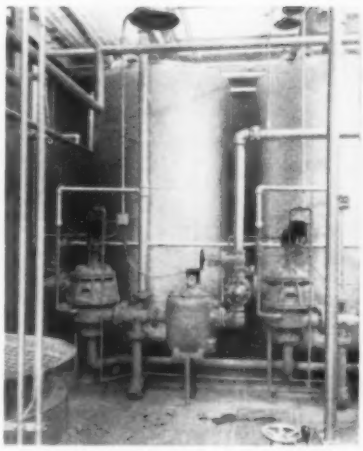


Fig 7. Water softeners from old plant were converted to automatic operation. Piping, grating is painted aluminum

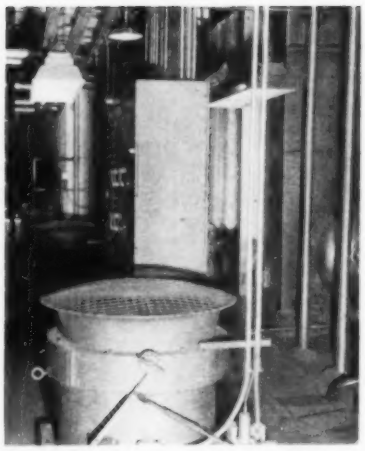


Fig. 8. Operating aisle at rear of boilers. Vertical propeller-type draft fans (foreground) saved on floor space

Several operating platform features are shown in Fig. 9.

At the far end of the main steam header (Fig. 9) are shown the chemical mixing tanks and pumps for controlled pumping of chemicals to the boilers and to the deaerator. Adjacent to the chemical mixing tanks is the condensate return storage tank. A float regulated valve is provided on the condensate tank for 100 per cent make-up of raw water in the event of emergency.

Platform grating is rectangular with orientation for maximum visibility. The main steam header is stubbed for future boiler No. 3.

Flash steam is piped to the deaerator for feedwater heating. Blowdown is manually regulated by multiple port flow-control valves installed in each continuous blow-down line from the boiler steam drums. A chemical analysis is run daily at the test bench shown in Fig. 10. The existing relocated deaerator is shown adjacent to the test bench.

Steam for the deaerator boiler feedwater heating is also furnished by the exhaust from the steam turbine-driven boiler feed pumps. Additional or emergency steam is furnished by a reducing valve connected

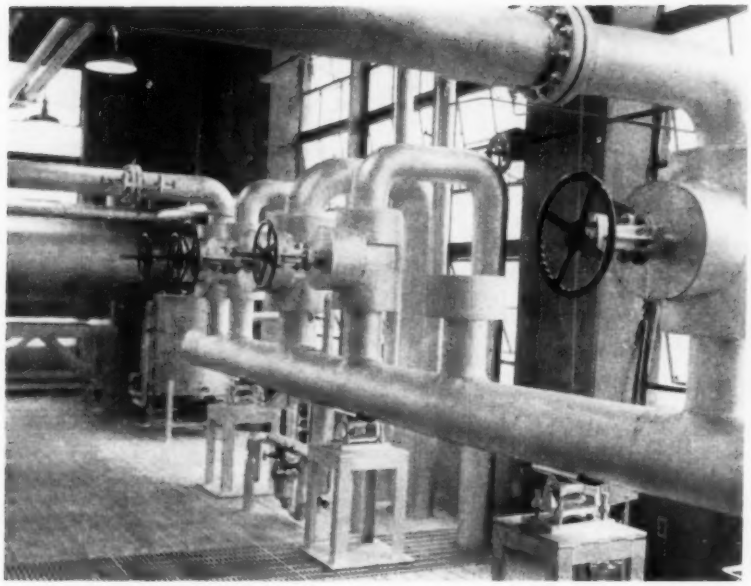


Fig. 9. On the operating platform. Main steam distribution header valve is 5 ft above platform, for convenience. At far end, chemical mixing tanks and pumps serving boiler and deaerator

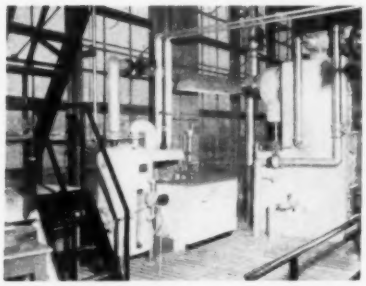


Fig. 10. Other platform features: ladder leads to roof and I.D. fans; continuous blow-down flash tank and test bench, center, give daily analysis

to the main steam header. The deaerator is provided with a vent-condenser venting to atmosphere and a multiport relief valve relieving to a separator-exhaust head, which is piped to the condensate returns storage tank.

Details of the operating aisle at the rear of the boilers is shown in Fig. 8. The motor control center for electrical distribution throughout the plant is shown behind the forced draft fan, for boiler No. 1. In addition to the usual combination magnetic starters with push buttons and indicating light, the motor control center contains a distribution transformer for single phase 110 v with a related breaker section for lighting and a related breaker section for single-phase plant motors, control, and alarm devices.

The roof-mounted induced draft fans with venturi stacks are shown in Figure 11. The principal reason for locating the fans on the roof was the saving it made possible in building cubage and initial cost. Estimated cubage saved was 20,000 cu ft. In addition, the arrangement shown is very satisfactory for outdoor operation. A special double layer of block insulation with each layer 2 in. thick was provided with a heavy copper sheath at the base of each fan to prevent the transmission of heat from the metal fan housings to the built-up boiler room roofing.

The completed central heating plant is shown in Fig. 5. A partial view of one louver located along the firing aisle is shown just beyond the pick-up truck. Steam distribution from the plant and condensate return to the plant are run overhead on steel pipe supports. The future coal storage and transport facilities will include a tile coal storage silo located opposite the wall louver shown. A coal chute from an upper level recirculation storage in the silo will connect through the plant roof to scales located on the operating platform. The scales will connect to a screw conveyor located under the operating platform across the front of each boiler. The screw conveyor will empty into spreader stoker hoppers.

Other pertinent features not described above include a complete flame failure and combustion safeguard system for the steam-assisted mechanical atomizing burners located at the side of each boiler. Ignition is presently by manual torches, at the request of station operating personnel; however, gas-electric ignition will be installed.

The side firing of oil and front firing of coal will permit a transfer from liquid to solid fuel in a matter of minutes after the coal firing arrangements are installed.

Each induced draft fan is provided with a removable duct section to permit future installation of a fly ash separator. Induced draft fans and motor drive are sized for future solid fuel requirements. One damper section in each unit is presently inoperative while the fans are operating at reduced capacity and static pressure.

All combustion controls include geared electric motor-driven power units to operate forced and induced draft vanes and oil fuel flow. Each power unit is provided with a hand-wheel permitting manual operation if required. After the boiler or boilers are put on the line all operations are automatic, and the plant requires only visual supervision.

Prime contractor was Ervin & Snow, Inc; Clark, Buhr & Nexsen, architect-engineers. THE END

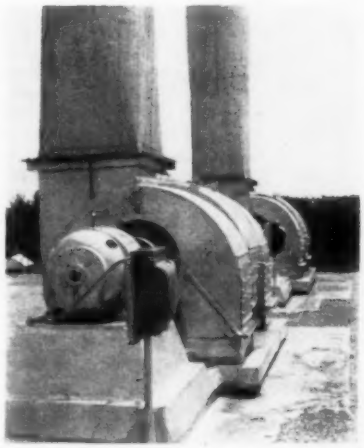


Fig. 11. Mounting I.D. fans on roof saved building about 20,000 cu ft

Main equipment at St. Juliens Creek

Boilers—Babcock & Wilcox Co type FF-15 No. 36, two at 34,000 lb/hr, 125 psig
Combustion Control—Hays Corp metering type
Flame Failure Safeguard Control System—Electronics Corp of America
Soot Blowers—Diamond Power Specialty Corp Model G98, rotating
Oil Burners—Babcock & Wilcox Co, steam "Y" jet with hinged register, steam atomizing, 125 psig
Pump & Heater Set—Boiler Brick & Refractory Co, horizontal shell and tube type
Safety Valves—Lonergan
Water Column—Yarway floatless Hi-Lo alarm
I.D. Fans—Clarage Fan Co
F. D. Fans—L. J. Wing Mfg. Co
FW Regulator—Copes-Vulcan type BI
Switchgear—Federal Pacific Electric Co, metal clad, 225 kva
Emergency Generator Set—Katolite Mfg. Co, diesel-electric, 100 kw

Hospital Completely Air Conditioned With Low-Pressure Turbine Units

Combination of power generation, heating and air conditioning in one central system gives excellent heat balance to big hospital

By E. J. WATTS *

THE LARGEST air conditioning installation in the intermountain area at the present time is at the Latter Day Saints Hospital in Salt Lake City. With the new 150 bed wing completely in use, the 500 bed hospital will be 100 per cent comfort-cooled by a low-pressure steam turbine-driven centrifugal refrigeration unit.

The installation is very well balanced, using steam to generate electric power, then taking the discharge of the generator-turbine and using this steam for air conditioning. In the winter, the exhaust steam goes to the heating system. In the summer, the exhaust steam goes to the low-pressure turbine driving the compressor.

Chilled water at 45 F is pumped from the 675 ton capacity low-pressure steam turbine-driven centrifugal refrigeration machine, located in the basement of the new hospital power plant, to a header in the main hospital building basement. From there it flows to the seven zones in the hospital. The water is returned to the chiller at 55 F. The 8 in. supply and return mains have a total equivalent length of over 1300 ft.

Low-pressure steam (10 psi) from the exhaust header of the two 400-kw back-pressure turbine-generators drives the steam turbine direct-connected to the centrifugal compressor. During the heating season, the exhaust from the turbine generators furnishes steam for space and water heating. The low-pressure steam turbine, operating at 4320 rpm, exhausts to a 1300-sq-ft, 2-pass condenser at 4-in. Hg absolute. At full load the 740-hp turbine requires 17,890 lb of steam per hour.

Cooling-water for the refrigerant condenser and the steam condenser is circulated by means of a 60-hp, 1750-rpm end-suction centrifugal pump. 1865 gpm is pumped through a 10 in. line from the cooling tower, through the 2-pass refrigerant condenser and steam condenser in series. Water off the tower enters the refrigerant condenser at 85 F, leaves at 95.7 F, where it enters the steam condenser and then returns to the cooling tower to complete the cycle. The condensed steam is pumped by one of two hot-well pumps, to the surge tank above the boilers, from whence it flows by gravity to the deaerator. Then it goes to the boiler feed pumps, on to the boilers through the high-pressure steam turbine generator, to the low-pressure steam turbine driving the centrifugal machine; winding up in the steam condenser, to complete the cycle.

The 45 F water leaving the chiller is pumped by one or two horizontal split-case centrifugal pumps, each driven by a 50-hp, 1750-rpm motor. At full load the two pumps (operating in parallel) circulate 1620 gpm against a 160-ft total head. The chilled-water piping system characteristics are such that one pump will circulate approximately 1260 gpm, or will handle up to 525 tons of refrigeration. Thus, only during peak cooling requirements is it necessary for the pumps to be in operation simultaneously.

Centrifugal refrigeration machine maintains constant outlet-water temperature by means of a temperature-recording type controller, having a temperature-sensitive element in the outlet water line at the chiller, which actuates the steam turbine governor, thereby increasing or decreasing the speed of the turbine, automatically, as required by the load. The centrifugal refrigeration machine is stable to 10 per cent of its rated capacity. The automatic control operates from 100 per cent to 30 per cent capacity. Manual regulation is provided from 30 per cent to 10 per cent load. With steam turbine drive excellent control, over a wide range of capacity, is maintained. The refrigeration machine is protected by safety controls, to stop the unit in the event the chilled-water temperature approaches a point close to freezing, or should the liquid refrigerant temperature in the cooler approach a predetermined low point. A high pressure cut-out is provided to stop the machine in case of excessive high condensing pressure; and, a low-pressure cut-off is installed to stop the unit in the event of an excessively low suction pressure.

An oil-pressure-operated switch is connected to the main compressor oiling system. Its function is to cut

* Worthington Corporation

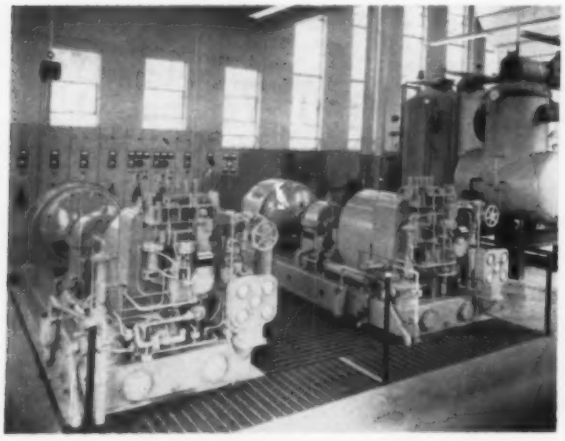


Fig. 1. Two 400-kw steam turbines which drive generators supplying hospital power and lighting. Low-pressure steam from these supplies heat system and compressor turbines

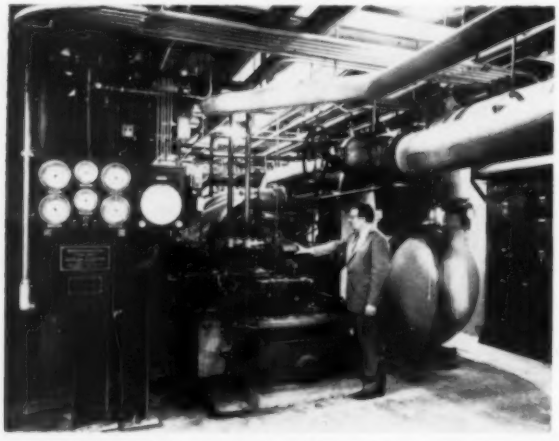


Fig. 2. View of low-pressure turbine-driven refrigeration compressor, which maintains constant-temperature outlet water through operation of controls which actuate turbine

out the auxiliary oil pump when the main compressor has reached a speed at which the service oil pump is delivering sufficient oil pressure for operation.

A single-pole oil-pressure-operated switch is used as a low oil-pressure switch. In the event the main oil pump fails, and the auxiliary oil pump cannot maintain sufficient pressure, this switch opens and shuts down the machine.

A trip solenoid, located on the turbine, will shut down the turbine — should the protective devices fail. An electric heater is installed in the compressor oil chamber to keep the oil warm during shut downs. The control circuit is so arranged that the centrifugal machine cannot start until the chilled-water pump is running. The cooling tower pump is interlocked with the control circuit in a similar manner.

The job was engineered to match the restricted space available in the power plant building. Thus, the turbine centrifugal refrigeration machine, chiller and refrigerant condenser were set in a space 15-ft by 18-ft by 9-ft high. The steam condenser is set between the two steam boilers, with its axis at right angles to the axis of the refrigeration machine.

Because of the low headroom, the 24" diameter exhaust from the steam turbine is horizontal, with one 90-deg long sweep elbow turning the exhaust line to the side inlet of the steam condenser. Despite the existing conditions, the refrigerant and steam condenser tubes are readily accessible for servicing, and provisions have been made for maintaining the centrifugal compressor and steam turbine.

With the installation of the centrifugal refrigeration equipment, the hospital power plant heat balance is complete. As mentioned earlier, the exhaust steam from the turbine generator is used for space- and water-heating during the off cooling season, and when this demand drops off, it is picked up by the refrigeration equipment. The turbine-generators, low-pressure turbine-compressors, condensers, hot-well pumps, and chilled-water pumps are manufactured by the Author's company. Power Engineer E. C. Nielson, Jr. is in charge. THE END

Electrical Load Grows in Buildings

IN CASE you aren't familiar with the Building Research Institute, a few words of explanation might be helpful to acquaint you with one of the most important groups of people in the field of industrial research. BRI is an association of influential people who represent every phase of the construction industry: architects, designers, manufacturers, building owners, utilities, trade associations, technical societies, government construction agencies and the members of the press concerned with this field. It is affiliated with the National Academy of Sciences-National Research Council.

The Institute has one primary purpose: to promote the advancement of building technology by serving as an unprejudiced forum for the exchange, development, and dissemination of information. Its members are organizations and individuals in the building industry and the related professions.

Some months ago a special task force was set up to survey the subject, in the hope that information could be gained which would be helpful to designers of buildings and electrical systems. A three-part survey was conducted by the task group:

1. Twenty-five agency and industry designers and building owners responded to a questionnaire on *design* of electrical loads for buildings;

2. Six equipment manufacturers did the same job on electrical *utilization equipment* that comprises most of the electrical loads in buildings;

3. Twenty-one power companies answered a questionnaire on *actual load growth* from their records of office buildings, hospitals and industrial plants. The findings of this group are most enlightening; let's take a look at the highlights.

With the exception of the abnormal power load increase in industry necessitated by World War II, the greatest general load increase has come in the last five or six years. This is due to the tremendous increase in air conditioning, new appliances, and added lighting, of course. In attempting to find out *how much* the electrical loads of buildings have increased, the group used a ten-year period as a base, and found these startling facts from the survey:

Industrial plants have increased about 96 per cent.

Office buildings have shown an increase of 91 per cent.

Hospitals have increased their loads by 53 per cent.

Utility companies have felt the shock of this load increase in existing buildings, and have absorbed it — along with the *normal* load increase that comes with a population increase. However, both designers and utilities are vitally interested in learning what can be expected in the future. The questionnaires sent out by the BRI task force were so phrased that the answers would serve a useful purpose by doing three things: 1, finding out how others tackle the design problem; 2, reporting significant findings that may improve agency policies and practices; and 3, emphasizing the importance of the problem.

Their final report stresses the fact that the conclusions drawn in it are by no means a design criteria for future buildings. We feel that the information obtained through the survey is of great importance, however, because it can be of help to power engineers, in the form of statistical and historical information, to guide them in design of electrical systems.

Questions and Answers

A few of the most pertinent questions and answers are of sufficient interest to our readers that we quote from the report as follows:

Q: What types of buildings are affected most by increase in loads?

A: Industrial plants, apartment buildings, office buildings, and hospitals; given in decreasing order.

Q: What has been electrical load growth in past ten years?

A: Hospitals 53 per cent, office buildings 91, industrials 96.

Q: Where additional facilities have been installed in existing buildings, in how many years were they used up?

A: Thirteen years, on the average.

Q: What *per cent* future increase in demand should be allowed for new buildings?

A: Hospitals 40, office buildings 35, industrial plants 45. (These are opinions of those answering the questionnaire.)

Q: How many years should be included in estimating future increases in load?

A: Hospitals 22, office buildings 15, industrial plants 8. (Again, based on opinions only.)

Q: What per cent of the total new building cost should be allotted to electrical power distribution?

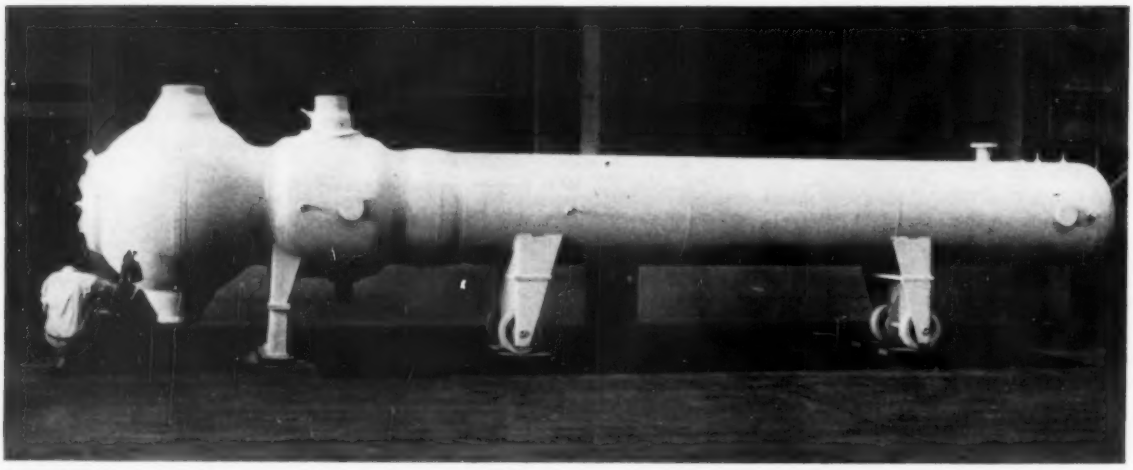
A: Hospitals 10, offices 9, industrial plants 11.

Q: Should additional transformer capacity be installed, over and above present needs?

A: Yes; average of replies was 33 per cent.

The report of the task force gives actual data from forty selected cities throughout the United States, supplied by the power companies serving them. This data includes load figures for four types of buildings, broken down into three principal loads: air conditioning, lighting, and other load. It is very educational for designers and utilities alike.

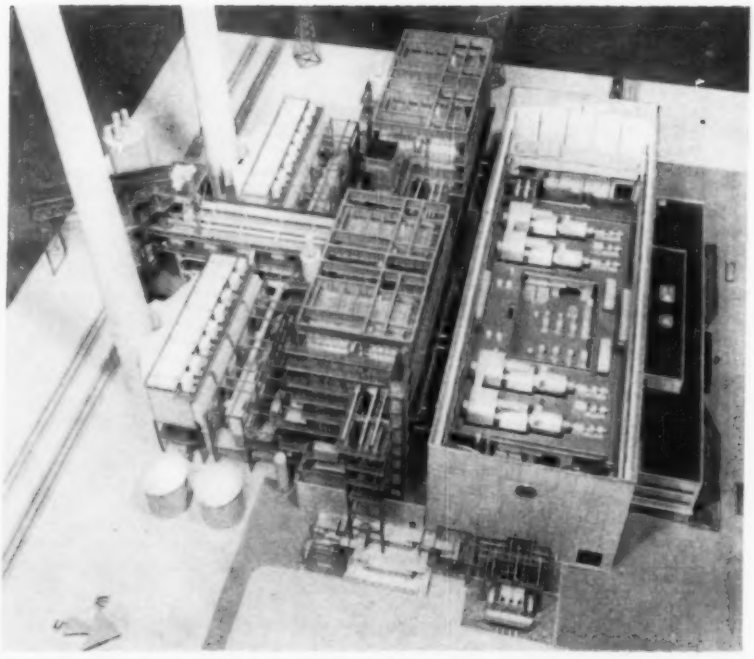
Editor's Note: — "Electrical Load Growth in Buildings" is the BRI Technical Reprint No. 11; it is free to Institute members, but can be purchased otherwise at a price of $1.00. (It is well worth the price, we think.)



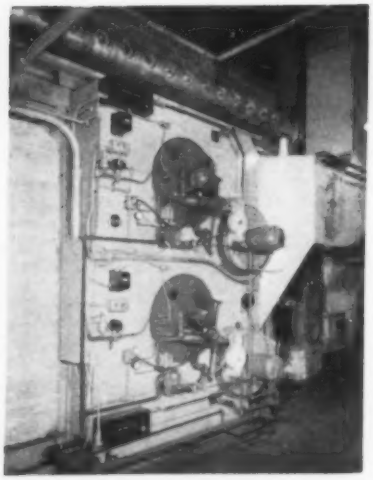
Something new in feedwater heater design is this 3000-psi, 7700-sq ft, spherical-head unit built by C. F. Braun & Co for h-p h-t application. All-welded construction eliminates flanges and bolted joints, does away with danger of leakage at such points. Spherical shape is ideal for withstanding thermal stresses from shock of quick start-up or sudden outage

POWER ENGINEERING'S NEWS REEL

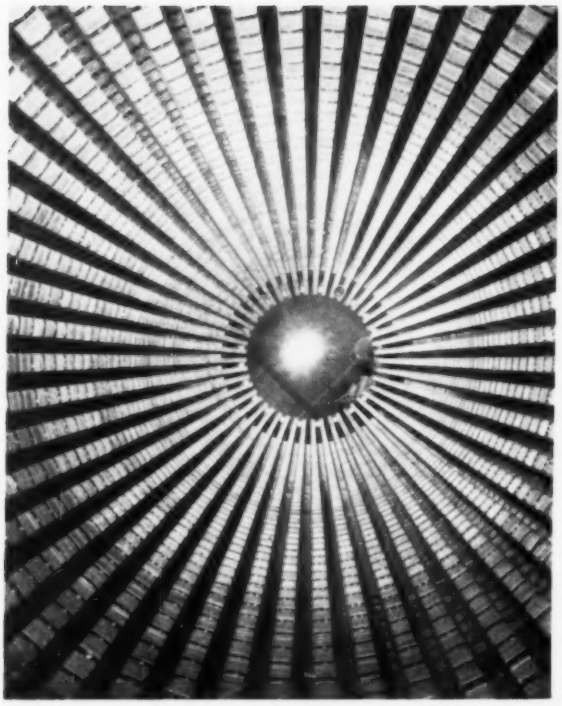
Spherical waterbox is made from two formed steel hemispheres, is integral with tubesheet and shell of heater. Tubesheet gives smooth stress flow-path



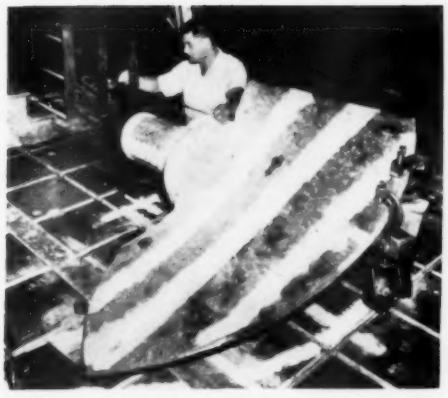
Here's a model of the big Bergen (N. J.) Station of Public Service & Gas Co, scheduled to go into operation late this year. Note the 290,000-kw, cross-compound, quadruple exhaust turbines, developed by Westinghouse for the plant. They will use steam at 2350 psi, 1100/1050 F, drive 3600-rpm generators



Big oil conversion job has been completed at Little Falls Laundry Co (N. J.) Erie City boiler (45,000 lb/hr) now has two Calorex Roto-cup burners



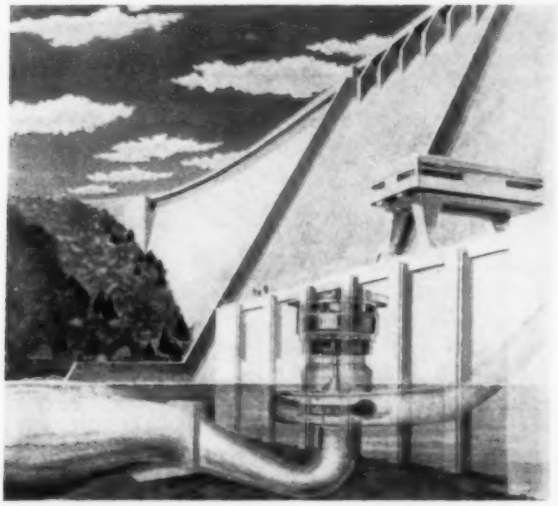
Nope, no sputnik, but just plain overhead lights shining down through a 430,000-lb generator stator being made by G-E. Workman at top has just completed stacking over 200,000 steel punchings. Unit will produce 156,250 kw

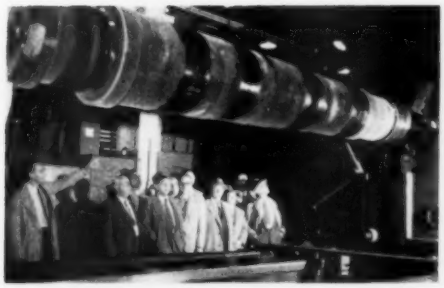


Blades of stainless steel which will last well beyond the year 2000 are being cast by Allegheny Ludlum Steel to replace blades of an old Kaplan turbine in a Chicago plant

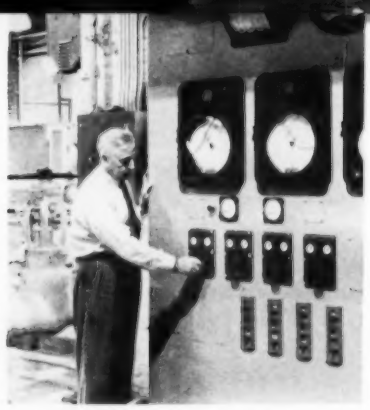
Engineers in shorts, the authentic Bermuda kind, inspect damage in main control room of Bermuda Electric Light Co following an explosion-fire. Cause was deterioration in insulation of a main bus bar selector switch bushing. CO_2 fire extinguishing system smothered blaze immediately

How it works at TVA'S Hiwassee Plant: the world's largest reversible pump-turbine, made by Allis-Chalmers, operates as a pump and delivers 3900 cfs against a 205-ft reservoir head. As turbine, it generates 80,000 hp at 190-ft head





Getting the works at the works are members of the Technical League, which is made up of male employees of Wisconsin Electric Power Co. Here the group visits Allis-Chalmers' steam turbine department, with Warner C. Frazier (l)



Answer to the maintenance problem lies in approaching the problem in the right way. This outline helps. It is fifth and last in this series on the newly built power plant.

So You've Begun Operating That New Industrial Power Plant

By PAUL N. GARAY

EXTENT OF the maintenance program for your new plant should be in keeping with the investment in equipment; but whatever the amount of your equipment, planning will help keep it operating dependably and cheaply.

The second article in this series (POWER ENGINEERING, October, 1957, page 86) suggested a system of record keeping which will simplify your maintenance job. Whether you use this system or any other good system, complete records should be kept. The execution of your maintenance program should follow your plans, with as few emergency deviations as possible. Too many emergencies indicate inadequate planning.

A large amount of overtime should be avoided, but no overtime at all indicates extravagant planning. Correct costing is important when analyzing the adequacy of your plans, because the whole purpose of your plant is to assure continued production at the least cost. Breakdowns, necessitating high-cost substitute services, or shutdowns, are costly.

In formulating your maintenance program, consider the several categories of servicing which should be covered: 1, breakdown maintenance; 2, preventive maintenance (by the calender, operating hours, or the like) including routine lubrication and inspection; 3, corrective maintenance, which is scheduled because of conditions which may become apparent during routine inspection.

Establish a philosophy of maintenance for each item of equipment. Breakdown maintenance is usually applied only to those units which will not cause shutdowns or dangerous conditions upon failure. Such small items as sump pumps, blowers, etc, are not serviced beyond occasional lubrication and casual inspection.

Preventive maintenance may include routine lubrication, and major lubrication (which requires disassembly or oil change); re-packing, testing, adjustment of bearings, cleaning and adjusting of linkages and control accessories, and other work as recommended by the manufacturer. This work can be scheduled with respect to manpower availability and availability of spare equipment to cover necessary outages.

Corrective maintenance is performed to repair faults which may have been discovered by inspection. I am not generally in favor of major disassembly of any small unit to discover faults, since these will generally reveal themselves by noise, vibration, overheating, loss of performance, leakage or excessive current draw. If you have a practical "test maintenance" philosophy for a small plant, these external symptoms should be closely watched for, as part of routine operating procedure.

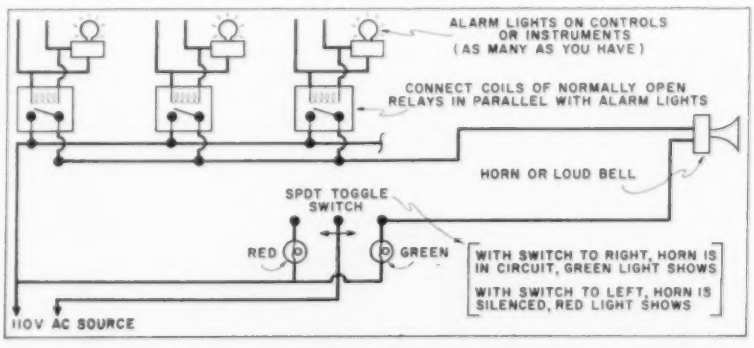
A good clamp-on ammeter, for example, will show operating current of a drive motor and will not require disassembly of the unit. If the motor load is normal, it won't always mean that the machine is okay, but a motor which is using overload current certainly is a good tip-off to trouble.

Checking performance figures is another good way to spot trouble. A pump which fails to deliver rated shut-off head, or a turbine that fails to come up to speed at its rated steam pressure and pump output pressure, is probably in need of closer inspection.

When pump or turbine casings are open, look at condition of shafting in the way of bearings and packings. Inspect turbine wheels and impellers closely for cracks, especially at points of stress concentration. Use an oil and chalk method, fluorescent dye, magnetic particle, or any other common method of inspection. When disassembling or assembling machinery, follow the instruction book. Don't work by "feel."

The third article in this series (POWER ENGINEERING, December, 1957, page 83) touched on spare parts storage and inventory. A full inventory of spare parts is impractical, since a complete stock of spares means an inventory which costs money to buy and provides no return on the investment. Try to limit your inventory to those items which move regularly and which cannot be readily obtained in case of breakdown.

An economical tool and equipment inventory will include specialized equipment such as valve-reseating machinery, cylinder bores, etc, only


ALARM LIGHTS ON CONTROLS OR INSTRUMENTS (AS MANY AS YOU HAVE)
CONNECT COILS OF NORMALLY OPEN RELAYS IN PARALLEL WITH ALARM LIGHTS
HORN OR LOUD BELL
SPOT TOGGLE SWITCH
RED
GREEN
WITH SWITCH TO RIGHT, HORN IS IN CIRCUIT, GREEN LIGHT SHOWS
WITH SWITCH TO LEFT, HORN IS SILENCED, RED LIGHT SHOWS
110V AC SOURCE

Lights indicating abnormal readings can be hooked into a horn circuit like this

if the cost can be justified by the money that may be saved by the use of such special tools. In some cases (valves of all kinds, especially) it is possible to rebuild equipment at a considerable saving over replacement. This can be done either by your own crew or by an equipment rebuilding firm.

In setting up a lubrication program, the guide provided by Table III may be useful.

In addition to lubrication and oil changing, other preventive maintenance is recommended in accord with a study of the manufacturers' instruction books. It is good practice to assign daily tests and inspections, as well as lubrication, by means of a set of standing orders for the plant.

For maintenance which must be done at longer intervals, study the instructions for each piece of machinery and set up a list showing the items of work which must be performed once a week, once a month, once or twice a year. The list should then be worked into a reminder type of schedule, or it may be made up on large sheets, one for each time period. At the end of any time period, all the items on a sheet should have been crossed off.

Don't Forget These

Don't forget the maintenance of systems which are not covered by specific machinery headings. These items may include:

Fill fuel oil tanks twice a year to the overflow, to coat the tank thoroughly. Drain or pump water out of the bottom of oil storage tanks once a year. Lift the safeties each time steam is raised (but don't lift until boiler is at 75 per cent of normal pressure).

Test safeties twice a year, and re-set as necessary. (Don't try to change a valve setting by more than 10 per cent, as the spring may be jammed tight if you do.) Blow down all metering lines once a month. Blow down your CO_2 recording system piping weekly, and clean the unit thoroughly. See that every valve and every machine in your plant is operated briefly once every two months at least.

Clean out dirt legs on steam lines twice a year. Blow down water tanks every three months until clean water flows. Inspect every month, and clean out the furnace flues and uptakes when necessary. Clean the deposits from induced draft fans every three months, or more often if they are subject to rain water drips.

Blow soot at least once every night. Inspect and oil up the ladder rungs, cables, pulleys, and handrails around your stacks every two months.

Look your plant over for locations which may collect unwanted deposits, or may corrode, or may stick or seize, and inspect these spots occasionally. Then, add the machinery maintenance outline to this special list to complete your maintenance program planning.

Maintaining Instruments

Instrumentation is best maintained with a minimum of "entering." Routine care should include blowing down the lines leading to the instruments, occasional bleeding of the air releases on the instruments, and changing pens and charts. The exception is the type of unit exposed to corrosive conditions, such as the CO_2 recorders used in boiler rooms. These will require regular cleaning, watering, filter changing, and adjustment with a comparison instrument (a rough comparison is to hold your breath for a minute, then expel into the intake of the CO_2 indicator; it should show about 4 per cent CO_2 in your breath). The pipes leading to the boiler from this instrument are also a source of annoyance, due to corrosion.

Should you for any reason suspect that any instrument is off, check against the instruction book for probable causes of trouble. You may find that although the manual will explain in great detail the installation, calibration, balancing, repair and other adjustments to the meter, very little mention is made of the usual simple troubles which are probably responsible for a malfunction. Should the connections, piping, wiring prove to be in order, and the instrument properly bled (when applicable), it may be wise to call for a technician.

When he arrives, notice the simple preliminary steps he takes to check out the instrument before he starts seriously looking for defects. Inasmuch as all instrument manufacturers are anxious for their equipment to perform properly, their technicians will be glad to advise you of simple checks and repairs you can undertake.

Draft gages are subject to very little trouble. Most malfunction will occur as a result of a leak or blockage in the lines leading to the boiler. The second common type of malfunction occurs as a result of an enthusiastic operator blowing into the piping to "clean it out," thus resulting in ruptured diaphragms or broken linkage.

Pressure gages do not require care after the initial calibration against a

Table I. Here's a basic outline for approach to an intelligent maintenance program. Be sure the crew is well-equipped

1. Prepare records, gather equipment data.
2. Compare routine maintenance records with the equipment costs to evaluate the amount of care that is warranted.
3. Establish a preventive maintenance program.
4. Evaluate the corrective maintenance needed based on the importance of the equipment.
5. Establish a corrective maintenance program.

Effectiveness of the program can be appraised as follows:

1. Analyze the history of breakdowns in your plant over a period of time.
2. Convert the list of breakdowns to a certain amount of money lost considering all factors such as idle labor, spoilage, re-work, overhead, overtime, lost production dollar, and the like.

Modify your original program to produce the optimum results, dollar-wise. Don't be discouraged if results don't show up immediately, since it takes time for sufficient data to accumulate for valid analysis. However, to measure the results of your program, use these comparisons:

1. Comparison of maintenance hours to productive hours.
2. Percentage of total maintenance expense to total sales billed.
3. Comparison of total maintenance expenses to total capital investment of plant and equipment.

Table II. Safety precautions should be posted above certain equipment. Most important is a set of boiler safety rules

1. Never light a burner from a hot brick wall.
2. Never light off until the firebox has been purged of all possibly explosive vapors.
3. Never enter a boiler drum carrying a 110-v extension lamp. Use a battery lamp or a special low voltage extension.
4. Never leave an open blowdown valve unattended.
5. Never steam the boiler when the water has dropped out of the glass. If this happens, shut down immediately, keep feeding water, and make an inspection as soon as possible.
6. Check gage cocks on each shift, and blow out water glasses and columns at least daily.
7. Never cut a boiler on the line unless its pressure is within 5 per cent of the line pressure.
8. Try your safety valves whenever bringing a boiler up to pressure.
9. Never attempt structural repairs without authorization and experienced personnel.
10. Safety valves should not be changed by adjusting the spring if they are more than 10 per cent off. Always raise the valve from its seat with the lifting lever when the pressure nears three-quarters of rated pressure. Test by popping with pressure every three to six months.
11. Lock all valves closed that might endanger workmen. Be sure to trace out any lines being worked on, to avoid unexpected and dangerous flows.
12. If ignition is delayed, stop and make an investigation. Never allow a boiler to pant.

Table III. Guide to setting up a lubrication program. Post a checklist for all these jobs. The program should take very little time daily, will make a great difference over the long haul

Oil cups	Fill daily
Oil sumps	Check and fill daily if needed
Soot blower and other h-t bearings	Lubricate twice each week
Grease cups	Give turn daily, fill weekly
Pressure fittings	Grease weekly on part-time equipment
Important bearings	Grease daily
Sump pump grease cups	Grease every 2 weeks
Flexible couplings	Grease or oil every 3 months
Reduction gears	Change oil twice a year except in very large sumps. For latter, change oil depending on analysis for abrasives, water, sediment, acidity, dilution
Engine and compressor sumps	Change oil as directed by manufacturer, but at least twice a year
Ball bearings on electric motors	Grease sparingly twice a year

test gage. On gages which are below the source of pressure, as in a boiler pressure gage which may be 20 feet below the steam drum, adjust the gage to show boiler drum pressure; when the steam drum is open, such a gage will then show zero pressure, regardless of the static water head in the lines. A pressure gage which vibrates unduly should be fitted with a snubber, or vibration damper, for continuous vibration will quickly wear out linkage.

Water glasses should be kept clean and blown down. On boilers of from 250 psi up, you may find that glasses must be replaced at least yearly, due to the etching effect of the boiler water.

Smoke indicators are usually sensitive and accurate, when maintained regularly. As the components age, or parts become dirty, the instrument requires recalibration. The sensing elements in the stack must be kept clean and properly aligned. Calibration is easily accomplished (when the stack is perfectly clear) by 1, setting pointer to the "clear" side, 2, shielding the pick-up eye and setting pointer to "Smoke" indication, 3, repeating this process until consistent settings are achieved. It is well to keep a spare rectifier and ballast tube on hand for these instruments, if electronic. Periscopes are in some cases cheap and satisfactory, and only require cleaning.

Flow meters and pressure and temperature recorders are complex but usually dependable. Unless you have available the services of a good precision mechanic or instrument man, have these instruments serviced by the authorized technician.

Flame failure safety devices should be checked each time a boiler is fired up, otherwise at least bimonthly. The test should embrace all the units in the shut-down circuit, and should cover all the conditions to which such a device will respond.

If your plant is provided with indicating lights for abnormal readings or malfunctions, all these lights can be very simply hooked into a horn circuit (see the figure). Such a system will provide audible alarm as well as visual signals. A typical plant may have hooked into this system the following alarms: high water, low water alarms; high pressure, low pressure steam; smoke; low feedwater pressure; low water level in feedwater storage tank; low water in condensate tank.

Last and important reminder: if you have low water cutouts fitted to your boilers (and you should have), test these monthly at least. The units are dependable, but sediment, corrosion scale, or other causes may cause them *not* to operate when needed. Be sure to guard against this.

Necessary Minor Work

There are many small jobs which could and should be done to make your plant an efficient modern installation. For instance, marking and identifying your plant equipment is infinitely more useful than mounting gages on stainless steel sheets, or polishing up all brass handwheels, or otherwise decorating your plant. Let your work be functional as well as decorative. Here's what you can profitably do:

Mark all pipes with kind of fluid, direction of flow, and pressure.

Number all valves, and mark to identify them as N.O. (normally open) or N.C. (normally closed).

Label all tanks with the kind of contents, capacity, and pressure. Machinery need be labeled only to identify similar units. When labeling machinery, use a number, a capacity, kind of service, and type of drive, i.e., No. 1 200-gpm turbine feedwater pump.

Damper arms and pneumatic operators should be marked, with lines showing limits of operation, and the words "open" or "closed." All controls should be plainly marked with their specific function, and with "open," "close," or "increase," etc., as applicable.

Gage faces should be marked with lines showing desirable limits of operation. This may be done by painting colored sectors on the face, or on the glass.

Electrical switch boxes should be plainly marked to indicate what they control.

Try to arrange banks of gages so that in normal operation all needles point in the same direction.

In some cases, I have found it well to post above certain machinery items a short list of safety precautions, as well as operating pointers. The most important set of rules to post are the boiler safety precautions (Table II). Your crew should learn these, and observe them. There are other rules, instructions, schedules, that can be posted. Put these in locations where they will not merely cover a wall, but where they will be readable and do some good.

Installation of burner racks and furnace equipment is generally left to the plant crew. Make your racks such that they are easy to use, will not cause drips or fire hazards, and are close to the operating positions. Install, also, a holder for holding burners while cleaning. If you can devise an air or steam blow arrangement to clean your burners, your operators will save much time.

A valuable piece of equipment is a sizable board showing a heavy line diagram of the piping systems of your plant. Where an important valve is shown, you can use an inserted peg to show "closed," or an absent peg to show "open." A supply of pegs can be kept in holes at the bottom; or you can have little T-headed pins which are put into holes denoting valves, and can be turned to show open or closed. I have even seen some boards rigged with lights. This visual board is valuable because it will enable an operator at a glance to see how his plant is set up; it will enable an engineer coming on the shift to pick up information without wholly depending on the man who is going off; and it will serve as a quick guide to the plant systems in case of emergency. The shift engineer should be responsible for keeping the board accurate. In case of a larger plant, a list of machinery can be made, with "off" or "on" indicators alongside each item. THE END

About the author . . .

Paul Garay graduated from Northwestern University Technological Institute with a B.S. in mechanical engineering in 1941. He is a registered Professional Engineer in Pennsylvania and Maryland, and has had extensive experience both on the operational and administrative sides of power engineering. These five articles by Mr. Garay began in the September, 1957 issue, and line up as follows:

SEPTEMBER
Train Your Operators Right For Your New Industrial Power Plant
OCTOBER
How To Set Up Operating Records For Your New Industrial Power Plant
DECEMBER
Tools and Stores You Need To Run That New Industrial Power Plant
JANUARY
So You're Ready To Begin Operating That New Industrial Power Plant
FEBRUARY
So You've Begun Operating That New Industrial Power Plant

REPRINTS will be available of the set. Write The Editor, POWER ENGINEERING.

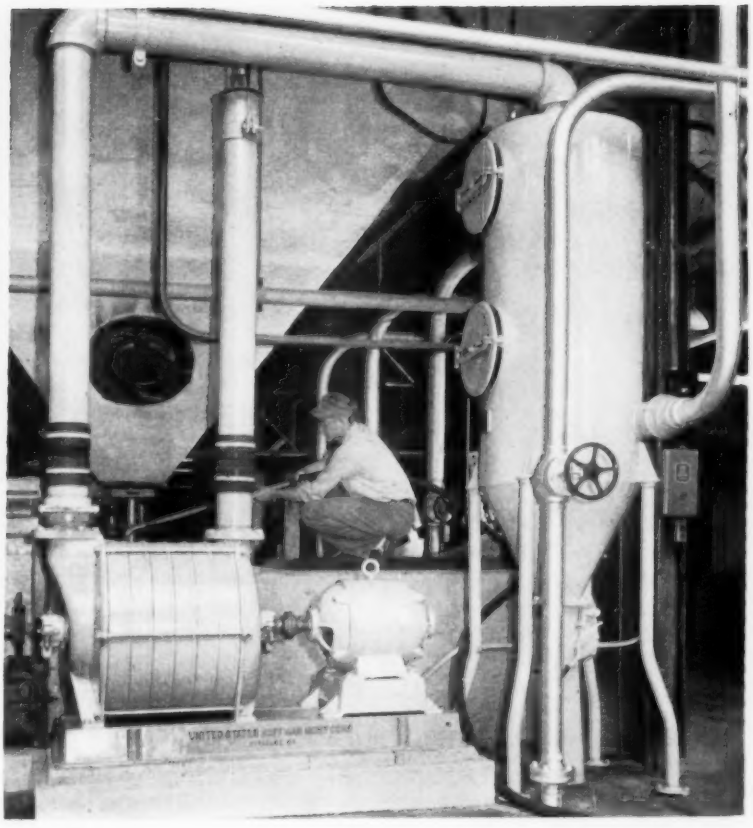


Fig. 1. (Above) Electrician using nonconductive brush on vacuum hose to remove dust from rear of control compartment door. Fig. 2. Heart of the central vacuum system, the 9½-in.-Hg exhauster and secondary cyclone dust collector

When the word is "Keep it clean," try a . . .

Central Vacuum Cleaning System

By IRA D. SINGLES *

SINCE POWER PLANTS were first put into operation, housekeeping has always been a problem. When coal was wheeled into the boiler room and thrown into the furnace by hand, and hot clinkers were dragged onto the floor spewing ashes, dust and smoke over everything and everybody, little attempt was made to keep things clean. With the coming of the modern mechanical stoker and ash handling equipment, serious thought has been given to better housekeeping.

Many plants, including Wyandotte, began working 24 hours a day, 7 days a week trying to keep boiler and turbine rooms comparatively clean in spite of the fact that they were handling many tons of coal and ashes every day. Their tools consisted of long-handled brushes, brooms, mops and other gadgets of their own invention which helped to keep things presentable. Most of these were like the housewife's old-fashioned feather duster — they merely stirred up the dust and let it settle somewhere else.

Wyandotte's present capacity consists of four boilers with a total output of 300,000 lb of steam per hr. This energy drives four turbine generators with a total capacity of 23,500 kw. A new 200,000 lb-per-hr boiler, and a 22,000-kw turbine generator, now under contract, will practically double the capacity of the plant within the next two years.

Several years ago, we investigated the possibility of picking up our dirt just as the housewife does, with a vacuum cleaner . . . only we couldn't carry the machine with us. The obvious solution, therefore, was to install a central vacuum system.

We found there were several excellent machines on the market, and one ideally suited to our particular needs was a six-stage machine which produced a vacuum of 9½ in. of mercury, manufactured by the U. S. Hoffman Machinery Corporation. Together with two cyclone dust collectors, known as the primary and secondary receivers, we installed this unit and a system of piping.

This system, all smooth-wall pipe and fittings, reaches every part of the boiler, turbine and coal-handling rooms. The outlets are spaced approximately 45 feet apart, so that a 25-ft length of hose reaches everywhere. Blanked-off outlets were also provided for expansion into the new boiler and turbine rooms.

Uses Vary Widely

Vacuum system was originally installed to pick up overhead dust and dirt which settled onto the tops of boilers, breechings, gratings and settings. Previously this was knocked down onto the boiler room and other floors, and made life miserable for men working below and the men doing the dusting. It was also detrimental to operating equipment. On clean-up days, dust often settled on transmission belts causing them to glaze and slip. Motors and switchgear had to be blown out frequently. The vacuum system has eliminated this nuisance almost completely.

* Plant Engineer, Wyandotte Municipal Power Plant, Wyandotte, Mich.

Fig. 3. Cleaning the top of a boiler drum—a difficult and dirty job made easy and done better by vacuum cleaning

Fig. 4. Siftings up to one-half inch in diameter are picked up easily as employee cleans top of ash hopper in basement

Our cleaner is being used in many places never thought of when the original equipment was purchased. It is also being used many more hours than first anticipated. The coal-handling and crusher rooms are periodically cleaned. This used to be a job with a broom and shovel. Fine dust settled on a man's clothing and skin. Now, the vacuum hose and attachments are pushed along, and the layer of fine dust disappears into the connecting pipe and down to the receiver.

The packing of our mechanical dust collector, installed in the breeching of No. Four boiler, showed evidences of leaking. But with four inches of powdery dust laying in a large oblong hopper, no one was anxious to investigate too closely. The solution: the vacuum cleaner was put to work, the packing examined and replaced, without discomfort.

Boiler inspectors are usually thorough and fussy. When they crawl through a setting, they want to see all the possible sources of trouble, without clouds of fine dust falling onto them whenever they tap a tube or support. They are especially interested in the areas where boiler tubes enter the drums. The usual method of cleaning is to direct a strong stream of compressed air around the tubes, and hope for the desired results.

Our new method is to blow the setting, and then finish with the vacuum cleaner. The boiler inspector today has no trouble in inspecting the entire boiler for signs of future trouble.

When a boiler has been taken off the line, stoker repairs are nearly always necessary. Each piece of metal or grate removed used to send up clouds of fine, choking dust. Now, the vacuum hose goes right along with the repairman, and eliminates the dust as it is created.

A hole was drilled through a concrete floor with a jack hammer. The fine concrete dust created by the operation was being drawn into a large motor driving a boiler feed pump. A vacuum-cleaner hose was placed close to the hole where the jack bit was turning, and the dust was withdrawn as the operation proceeded.

In addition, the machine is used to clean switchboard cubicles, switchgear, and other electrical equipment. It has the capacity to pick up almost anything that will pass through the suction hose. Small pieces of welding rod, overlooked in the corners since previous construction, small nuts and bolts, and pieces of coal from the coal room go rattling noisily down the pipes into the primary receiver.

As time goes by, we expect to find more and more uses for this versatile tool. We do not hesitate to use it wherever necessary, for the system is a glutton for work, and makes our working conditions easier and far more pleasant.

Description of Unit

In taking a detailed look at the machine, we find the exhauster housing consists of a series of cast iron sections with tongue-and-groove fit, held together with tie rods between inlet and outlet castings. The aluminum alloy impellers are statically balanced and keyed to a steel shaft. The entire rotating element is dynamically balanced to assure vibrationless operation. The machine rests on 2 in. strips of cork and is not bolted to the floor in any way.

The shaft is supported by ball bearings mounted in outdoor housings which supply lubrication. The bearings may be removed for inspection or replacements without disassembling the exhauster or its piping. Since the air is completely filtered before entering the assembly, the exhauster should give dependable service for years.

The machine proper is proceeded by two cyclone tanks which are called primary and secondary receivers. Dust laden air enters the primary tangential inlet and whirls around an internal baffle. All the heavier particles of dirt fall to the bottom of the hopper and only the fine dust is carried out of the top to the secondary receiver. Here the air receives a similar treatment and only the fine airborne particles rise to the inverted dust bags located in the top of the hopper.

Upward air stream, now moving at greatly reduced velocity, passes freely through the fabric, trapping the dust on the inside of the bags. The bags are shaken by an external device, when the machine is idle, and the dust from both collectors is dropped into the ash collecting system.

Discharge pipe from the exhauster is located ten ft above the machine and discharges directly into the power plant basement. No dust has ever been observed coming from this line — attesting to the thoroughness of dust removal by the separators.

Our machine was installed in February of 1954, and since that time has required a minimum of maintenance. A Westinghouse 25 hp, 3600 rpm, 3 phase, 440 volt motor drives the unit.

We feel that the equipment has paid for itself many times in direct labor of cleaning, and in improved conditions for the operating machinery, resulting in lower, easier and more efficient maintenance. There is an additional gain in the improved appearance of the place, and higher morale among the men. THE END

How to Write Specifications for High Speed Steam Turbines

Refinery and chemical plant engineers who write the specifications for high speed compressor drive steam turbines can save time, effort and money by checking these points before starting the job

By IRVING HAZLET*

IT IS HELPFUL to begin by consulting the steam turbine specialists who are associated with reputable turbine manufacturers in their major district sales offices. These men can be of great assistance in writing specifications, by offering advice on the various controls, protective devices, etc., that would be needed for the service involved; but don't let the representative of any one manufacturer try to influence the specification so that it is written too much around his own machine.

Steam Conditions

It is not only important to indicate the initial steam pressure and total temperature at the turbine inlet, and the exhaust pressure; it is also vitally important to list any abnormal steam conditions at which the turbine must carry full or reduced load. If the turbine will be subjected to wide swings in pressure, the specifications should state the maximum and minimum pressures for which it should be designed.

Power Requirements

In addition to the normal horsepower and speed requirements, the user may wish to have reserve power built into the turbine. This should be expressed in the specifications as a percentage of the maximum requirements. For example, if the turbine is rated at 5000 hp at 8500 rpm, and the reserve power desired is for operation delivering 6000 hp, the specifications should call for ability to deliver 20 per cent overload. If the process requires varied output from the compressor, it is well to define in the specifications the point at which the turbine-driven compressor will normally or generally operate. This allows the turbine manufacturer to design the turbine to have its best steam rate at this condition.

Steam Admission System

Most processes require the compressor to operate over a wide range of power requirements, for which automatic, multi-valve nozzle control assures the most economical operation of the turbine at all loads. With this type of construction each valve automatically controls the admission of steam to a separate group of nozzles. On decreasing load the valves close in sequence leaving only the required number of nozzles open to carry the load. As load increases the valves open nozzles as required, reducing throttling losses to a minimum. The specification should state "automatic, multi-valve nozzle control" if this feature is desired.

If the process requires practically constant output from the compressor, and the power requirement is not above 3500 hp (depending on steam conditions), a single valve inlet machine with hand nozzle control may be satisfactory.

Automatic multi-valve construction is slightly more expensive initially, but the extra cost will in many cases cancel out in steam savings over a short period of operation on variable load units rated as low as 1000 bhp. In addition to economy, the automatic, multi-valve type of construction is insurance toward long periods of trouble-free operation.

Flexible or Stiff Shaft?

Normally, in refinery and chemical processes, the speed range required by the compressor is limited and flexible shaft construction (i.e., with the first critical speed below the operating speed) for the compressor and turbine is very satisfactory. With modern designs and methods of balancing rotors, vibration at the critical speed is so minor that it is not noticeable as the unit is brought up to speed. When a particular process requires an unusually wide range of speed, such as a blast furnace blower application which requires alternate idling and delivery of full power at full speed, stiff shaft construction is usually preferred, since turbine manufacturers do not recommend continuous or prolonged operation at the critical speed.

These determining factors should be carefully considered before specifying the type of construction required for the application. If the operating speed is confined to the higher range, the stiff shaft turbine will be larger than the flexible shaft machine, resulting in unnecessary increased cost to the user. In some cases specifying stiff shaft construction may result in putting a limit on the number of stages that may be economically used in a turbine due to bearing span, making it increasingly difficult to design the turbine for its optimum efficiency.

Turbine Speed Control

Usual method of controlling turbine speed is by air signals from the compressor volume, pressure or temperature controller to an air head either integral with the turbine governor or connected to the governor hydraulic system by linkages. The

*Application engineer, Worthington Steam Turbine Division

Typical high speed turbine (10,130 rpm) driving a centrifugal compressor at a New Jersey oil refinery. Automatic multi-valve nozzle control gives efficient service

advantage of the air head integral with the governor is that the governor has complete control of the turbine governing at any speed for which the air head is set, no matter what changes in load and steam conditions. When the air head is connected to the governor hydraulic system, the main turbine governor only acts on a pre-emergency basis.

How Many Protective Devices?

Every high speed steam turbine should normally have at least three protective devices: 1. emergency overspeed governor (to be sparkless if used in explosive atmospheres); 2. low oil pressure protection; 3. pneumatic or solenoid operated shutdown to operate from the compressor protective devices.

Several other devices can be used, such as a high exhaust pressure trip mechanism, vacuum breaker, and high oil temperature trip mechanism. These are required on some applications. If they are not required, they should *not* be specified, since they cost money and may complicate the operation.

Lubrication System

One of the most important assurances of continued operation of the turbine and compressor unit is a dependable lube oil system. The lube oil system can be separate for the turbine and compressor, or combined. In a combined system, the lube oil pump is driven from the turbine governor shaft and delivers up to approximately 15 gal per minute in excess of turbine requirements for the compressor bearings.

Often a separate driven main oil pump is required. If turbine driven, make sure the turbine is of the heavy duty type suitable for continuous service, as the installation is only as dependable as its main oil pump. If the main oil pump is turbine driven, the auxiliary oil pump may be motor driven, and vice versa.

The specifications should state the temperature and whether fresh or brackish cooling water is available for the oil cooler. Twin oil coolers and filters with transfer valves may be a wise investment, as either series of a cooler and filter can be cleaned and maintained without shutting down the unit.

Experience has shown many contractors and owners that much of the piping for the lube system can be more readily and economically accomplished during installation by the contractor. This is especially true if lube system components are to be located some distance from the turbine and compressor. This can be accomplished by stating in the specification that the turbine manufacturer is to furnish only the piping directly connected to the turbine casing and to supply a schematic drawing of the lube oil system to the contractor which will show him the various line sizes and valve sizes.

Special Requirements

Usually, refinery and chemical plant turbines should have all the electrical equipment of the explosion-proof type normally specified as Class I, Group D. The specifications should inform the manufacturer of any other hazardous conditions such as corrosive gases, dusty operating atmosphere, and so on, which must be allowed for in designing and building the turbine.

Many turbine and compressor units are for outdoor installations. Here the specifications should contain the minimum and maximum expected ambient temperatures, and any unusual temperature or weather conditions which the turbine will encounter. Be sure to state whether the unit will be outdoors completely, or under a roof, or if there is any protection on the sides. Elaborate on whether dustproof covers, heaters in the oil reservoir, and possibly even steam tracing of the lubricating and governor oil lines may be required, if the unit is to operate in extremely low temperatures.

Steam tracing of piping should normally be done at the plant site, since this is a special requirement and for the manufacturer is an expensive, custom-built feature. THE END

Check-List Helps Prevent Fires On Construction Jobs

GOOD HOUSEKEEPING and good maintenance are fundamental in preventing fires and protecting property on construction jobs in the power, chemical, petroleum, nuclear facility and other industrial fields.

Stone & Webster Engineering Corp finds effective a special check-list which is used by job safety committees charged with safeguarding materials, machinery, equipment, permanent and temporary buildings and their contents.

"Fire prevention and protection necessarily must keep pace with the construction program," says the safety bulletin issued to Stone & Webster construction project personnel. "Concentration of values in confined or hazardous areas or in closely-grouped buildings must be avoided when possible. There should be no delay in installing fire protection equipment. Adequate protection must be provided as soon as combustible material, temporary building and contents are on the construction site."

Here is S&W's check-list for fire prevention and protection. This is a useful good housekeeping quiz for you to use. How many of these can you check off as points carefully watched in your construction program?

ELECTRICAL EQUIPMENT
- ☐ Switches
- ☐ Insulation
- ☐ Fuses
- ☐ Grounding

MATCHES or SMOKING
- ☐ Confined to places permitted
- ☐ Safety matches only

HEAT HAZARDS
- ☐ No combustible material in contact with steam pipes, furnaces, flues, etc.
- ☐ Ashes in metal containers
- ☐ Care and maintenance of salamanders and their location to tarpaulins, which must be fireproofed, and combustible materials
- ☐ Protection of combustible materials, and fire prevention in connection with welding and burning operations

FLAMMABLE LIQUIDS
- ☐ Handling and use
- ☐ Stored in approved place
- ☐ Safety cans used
- ☐ Tanks, drums and cans in good order
- ☐ No leaks

OIL AND PAINTS
- ☐ Stored in approved place
- ☐ No leaks
- ☐ Drippings properly disposed of

COMBUSTIBLE MATERIALS
- ☐ Stored in approved bins or containers

OILY RAGS AND WASTE
- ☐ All in approved metal receptacles
- ☐ Disposed of regularly

GAS (INCLUDING OXYGEN AND ACETYLENE)
- ☐ No leaks
- ☐ Turned off when not in use

REFUSE
- ☐ In approved containers
- ☐ Disposed of daily

LOCKERS AND CLOSETS
- ☐ Kept neat
- ☐ No accumulation of rubbish

TEMPORARY BUILDINGS AND CONTENTS
- ☐ Housekeeping in and around building
- ☐ Ample spacing between buildings to prevent fire communicating
- ☐ Storage of material and equipment
- ☐ Availability of fire-fighting equipment

FIRE-FIGHTING EQUIPMENT
- ☐ In place
- ☐ Easily accessible
- ☐ In working order
- ☐ Sprinkler valves open
- ☐ Sprinkler heads unobstructed
- ☐ Alarms in working order
- ☐ Checked and tested frequently

New Floor-Surfacing Material For Wet and Corrosive Locations

Four years of research have produced a new product which, manufacturer claims, is first material that is acid and shock resistant, and bonds perfectly with old concrete floors or walls. Half-inch application stands up under heavy traffic loads indoors or outside

MARKETING of a radically different floor-surfacing material has been started by a prominent manufacturer in this field. If all claims are true, this product might well be the answer to an age-old problem: that of applying a thin coating of repair material to old (or new) concrete or wood surfaces — and making it stick. In addition, a material which possesses both high impact strength and acid-resistance; one which can be applied inexpensively, and which will cure in a short period.

According to the developer, this material had an accidental discovery, in the company's own plant, when some left-over material from an adhesive research project was used by the plant engineer to patch a hole in the floor. After a year of hard use, a request was made for more of the material. Upon investigation, the first patch showed such remarkable performance that the research department immediately went to work on a new line of development.

Chemicals and Copolymers Used

After months of research, and a brand new approach to the problem, the combination of chemicals, copolymers and aggregate produced a finished product which was comparable to quarry tile without its brittleness and troublesome joints. The research had uncovered an entirely new approach to the technique of bonding; also, the new material had a very low shrinkage factor. Conversely, it had a low coefficient of expansion, and exceptional flexural strength; two properties lacking in thin concrete applications.

For years, industry has been searching for a "utopian" material which would do a really good job of resurfacing concrete floors, without performing expensive, and time-consuming preparatory work on the old floor. Furthermore, acid-resisting surfaces have always been in demand by food, dairy and pharmaceutical plants. Ordinary concrete, commonly used for industrial floors, has an average compressive strength of about 3000 lb per sq in. This new product, after air-drying for twenty-eight days, has a compressive strength of approximately 6500 lb per sq in.

Bonding Strength Very High

Bond strength of a material is its ability to stick to another material; also, the two types of bond are tensile adhesion and shear adhesion. Tests of this new product show that it has a tensile adhesion of 585 psi when applied to concrete, and a shear adhesion of 464 psi. Compared to a bond of concrete to concrete, the same values are 15 psi and 58 psi respectively. Also, the bonding power of the material to steel is practically the same as that with concrete. This in itself is remarkable; concrete has absolutely no bonding power to steel in most cases.

The manufacturer has tested the material on concrete and wood floors, in highly corrosive areas, on loading docks, traffic aisles, highways, sidewalks, and many other applications. Four years of such field-testing have convinced the manufacturer that it has the best material yet developed for the uses mentioned. Better than a half-million sq ft of the product have been applied in hundreds of plants — of all types; the performance in all applications is reported to be excellent. One extra quality inherent in the material is its resistance to freezing and thawing; this makes it ideal for out-of-doors surfaces such as ramps, loading docks and steps.

Editor's Note: — While floor maintenance is of more importance to industrial plant engineers, we believe that every power engineer is concerned with some floor maintenance.

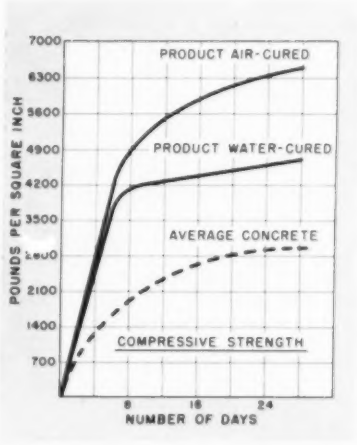


Fig. 1. Chart showing comparative compressive strength of product and average concrete in most industrial floors

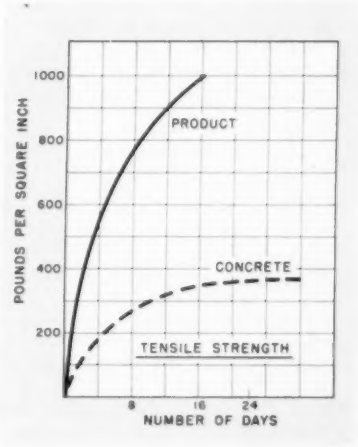


Fig. 2. This graph shows comparison in tensile strength of product with concrete, when air-cured vs water-cured

Being aware of a common problem shared by most of our readers, POWER ENGINEERING is always searching for new products or techniques which show promise of solving that problem.

Rough floors, caused either by erosion or corrosion, create hazards and discourage good housekeeping. Many patching materials have been on the market for years. Generally speaking, each of these has been developed for a specific application, and is not intended to be a general-purpose material.

Several factors are involved in the application of surfacing compounds used for floor repairs. First there is the problem of *bonding* one material to another; then, the new surface aggregate must be able to protect the bond, and also furnish the desired qualities of acid and shock-resistance, ease of application, and relatively low cost.

Floor maintenance is one of the greatest single problems in industry today; especially in process plants.

If this material has all the excellent properties it appears to have, power engineers will be interested; corrosion effect on concrete is always a headache in boiler plants, and in those plants using corrosive materials. For more information on this product write the Editor, or jot Concrete Repair Material on the enclosed prepaid Inquiry Card. THE END

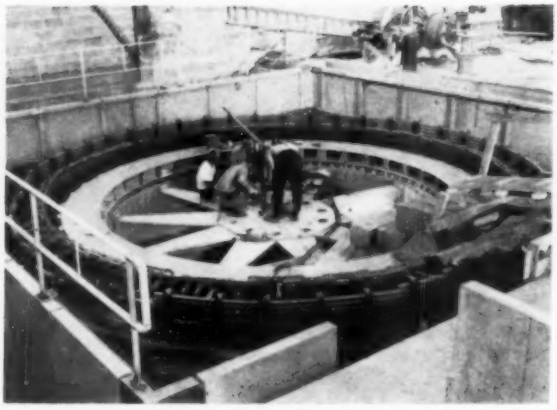


Fig. 1. (Above) Downstream end of wood-stave penstock pipe during construction period. 2,000,000 bd ft of Douglas fir were used. Fig. 2. Assembling the 70-mva generator

World's Largest Wooden Penstock

By EDMUND T. NESBITT

LARGEST WOODEN PIPE of its kind in the world is a feature of the new Chute Murdock-Willson power development, 100 miles due north of the city of Quebec. Built of wood staves, this pipe is 18 ft in diameter, comprises the first 5609 ft of an 8351-ft penstock.

Located close to the junction of the Saguenay and Shipshaw Rivers, the new plant supplies up to 70,000 kva to the Kenogami paper mill of Price Bros. & Co, Ltd. After 18 months of construction, it went into operation in October, 1957. Notable is the fact that the plant can be operated unattended, being controlled remotely.

Water enters the penstock from upstream through a canal 1000 ft in length, which was excavated in sand to a depth of 60 ft. This required sloping sides, and the canal is 175 ft wide at top, only 12 ft at the bottom. Normal water depth is 30 ft.

Intake gate is of steel, and is installed in a concrete structure. Normal water flow is 2500 cfs, maximum is 3200. This provides a head at the turbine of 263 ft.

Wooden section of the penstock is built from some 2,000,000 bd ft of $4\frac{1}{2}$ by 5 in. pressure-creosoted wood staves, bound with tar-coated steel bands on 6 in. centers at the intake end, $2\frac{3}{4}$ in. centers toward the discharge. Steel cradles 10 ft apart support the pipe, and these are in turn supported on concrete footings.

Remainder of the penstock is of steel, varying in diameter from 18 ft at the upper end to 15 ft at the powerhouse. Sections in 60-ft lengths were welded at the site, lifted into position by a 70-ton crane.

Immediately behind the powerhouse a steel surge tank rises 255 ft above the ground. Largest overhead tank in Canada, it is 90 ft high, 60 ft in diameter.

Tail race from the powerhouse was excavated out of almost solid rock. It is about 800 ft long, 40 ft deep, and 75 ft wide.

Variety of suppliers for this plant is impressive. Wooden penstock was furnished by Pacific Coast Pipe Co of Vancouver, B. C., the steel portion by Dominion Bridge of Montreal. Canadian Westinghouse built the generator, and Karlstads Mekaniska Werkstads of Sweden the turbine. A Woodward governor controls them, and actuates a 70-ton butterfly valve by Canadian Allis-Chalmers. Canadian General Electric made the transformers and the oil circuit breakers.

Steel towers for the transmission lines were fabricated by SAE in Italy, and were installed by Canadian contractors. The 200-ton traveling crane in the powerhouse is a product of Dominion Bridge.

Remote control equipment, supplied by R. H. Nichols, Ltd, Toronto, permits the Kenogami operator to control the unit. THE END

Fig. 3. Details of the wooden penstock construction. Wood staves are tongue-and-groove, have metal butts, were creosoted under pressure before delivery to site

Fig. 4. Looking downstream from intake structure. Over a mile of pipe is wood

New Brochure About Power Engineers Will Be Available to Readers

JOB OF THE power engineer in modern American industry is largely misunderstood or actually unknown by the general public. Even in business and industry there are many who are unaware of the place of the power engineer in our economy.

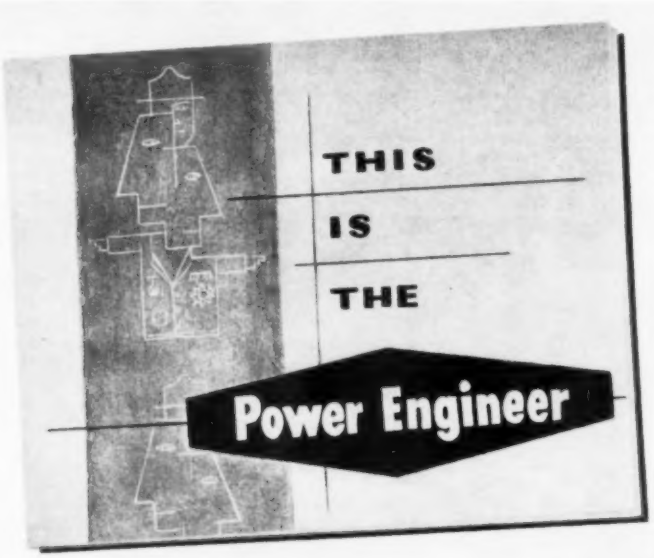
Where opinion does exist, it seems to be divided between those who believe a power engineer is some character who sits in a basement idly expectorating on the furnace door, or else is a white-coated individual busily polishing the name plate on a huge machine in a big electric utility station.

POWER ENGINEERING, realizing that this situation and its implications are bad for industry in general and power engineers in particular, decided to do something about it. Associate Editor R. C. Hagenmiller was assigned to interview, in depth, 18 individual power engineers in 18 different types of industry from Vermont to California, North Dakota to Texas, and report in detail on the duties and responsibilities of these men as representative of the profession as a whole.

Results of his 1,000-mile trip are presented in a 24-page illustrated brochure: *This Is The Power Engineer.*

Types of industry covered in the booklet include the following:

1. Large private utility
2. Small municipal utility
3. Atomic power plant
4. Petroleum refinery
5. Chemical plant
6. Steel mill
7. Primary aluminum plant
8. Textile mill
9. Pulp mill
10. Large manufacturing plant
11. Rubber plant
12. Mining
13. Meat packing plant
14. Brewery
15. Hotel
16. Hospital
17. Laundry
18. Consulting engineers



Illustrated 24-page booklet describes job of power engineers in 18 industries

This new brochure will be distributed widely in business and industry, and copies will be made available to all engineering and technical schools. Readers who would like to have a copy may obtain one by writing the Editor, POWER ENGINEERING, 308 East James Street, Barrington, Illinois. Copies will be mailed as soon as they become available.

Make Your Arrangements Now So You Can Attend American Power Conference in March

NOW IS THE TIME to start thinking about arranging your dates to attend the American Power Conference in March. As usual, the Conference will be held at the Hotel Sherman in Chicago. The dates are March 26, 27 and 28.

Sponsored by the Illinois Institute of Technology in coöperation with 14 other universities and colleges and nine professional societies, the American Power Conference is the only all-power conference now in existence in this country. This year's program marks the Conference's 20th anniversary.

Thirty sessions are scheduled for the 3-day meeting, which will also include a technical session on nuclear power generation. Ninety papers will be given, covering a wide variety of aspects of electric power generation and related functions.

Among subjects to be discussed are: new and exotic propellants such as fluorine, boron compounds and hydrazine; economics of fuel transportation; experience in the operation of the first commercial supercritical pressure steam electric generation station; high voltage transmission.

One or more sessions will be devoted to the generation, transmission and utilization of electrical energy, use of pump storage for hydroelectric stations, steam and gas turbines, industrial power plants, steam generators, and heating and air conditioning.

In addition to economics, discussion at the fuel sessions will deal with fuel availability and future power demand, the outlook for high energy fuels, and the energy aspects of underground gasification processes.

Four sessions are planned to cover the various aspects of nuclear energy power applications. A progress report on nuclear developments in the electric power industry will be given by a number of executives of electric utility companies, who will describe the current status of the various nuclear reactor projects in which their companies are participating.

A summary of the Conference program, arranged by subjects, will be published in POWER ENGINEERING next month for your guidance and easy reference.

Also, again this year during the Conference, POWER ENGINEERING will hold open house at the Hotel Sherman, for old friends and new. All Conference members and their friends will be welcome.

You Can Control Mechanical-Drive

Variables which affect costs include speed, inlet and exhaust pressure, initial temperature, and horsepower rating. Author offers pertinent pointers to help you get the most for your turbine dollar

By STANLEY STYRNA *

HORSEPOWER RATINGS of mechanical-drive turbines have been climbing steadily due to increased power requirements of driven equipment such as compressors, pumps, fans, paper machines and generators for industrial plants. Ratings of 5000 hp are now common, and the trend is still upward. When turbines of such large horsepower are used, care in selecting steam conditions and speed may result in substantial savings in turbine initial costs and fuel costs.

This is so because steam conditions and speed greatly affect a turbine's size, construction details, design details, and choice of materials, and these items directly affect a turbine's initial cost. Steam conditions and speed also determine a turbine's steam consumption and therefore its fuel cost.

There are some 300 multi-stage mechanical-drive turbines in this size range purchased each year. Approximately 60 per cent of these are condensing units. The primary application is as compressor drives in the process industries — petroleum, chemical, petro-chemical and paper. In most cases these industries have process steam requirements, served in part by non-condensing turbines. Frequently these plants have a variety of steam conditions and requirements, and turbine drives could be selected at a saving in cost, and still achieve the desired overall plant and process heat balance.

This article explains how steam conditions and speed affect a turbine's initial cost and steam consumption. It also shows how combined turbine initial costs and fuel costs vary over a range of steam conditions, speeds and ratings. The most economical steam conditions and speed for a given rating may be approximated from these data. It should be noted that only turbine costs of condensing turbines have been considered. The cost of the driven equipment, boiler, piping and condenser, will also be factors to consider in selecting steam conditions and speed.

Let us see what relationship exists between a turbine's steam consumption and its steam conditions. Steam conditions determine the amount of available energy in a pound of steam, which theoretically can be converted by a turbine into shaft horsepower. Steam at higher inlet pressures and temperatures possesses greater available energy than steam at lower pressures and temperatures. A turbine's steam consumption is a function of the available energy, and a matter of how efficiently this energy is converted into work.

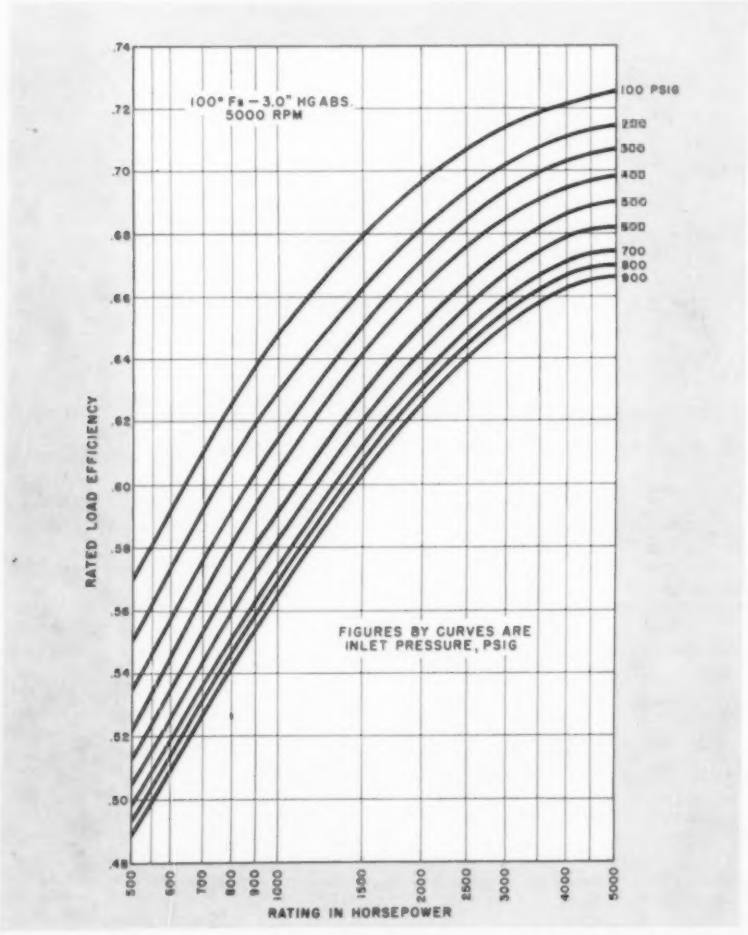


Fig. 1. Efficiencies of typical multi-stage condensing mechanical-drive turbines

Factors Affecting Efficiency

An efficiency level which is representative of the industry for mechanical drive turbines is shown on Fig. 1. Notice that as the inlet pressure increases, the turbine efficiency decreases for the same turbine rating. This loss in efficiency is a direct result of the higher steam density and lower steam volume of high pressure steam. When steam densities are high, the rotation losses of a turbine rotor become greater than for steam at lower densities.

Efficiency is further reduced because the low steam volume requires smaller nozzle and bucket heights, which increases the percentage of nozzle and bucket friction losses. The increased available energy of high pressure steam is therefore not fully converted into shaft horsepower because the turbine efficiency is reduced.

Temperature also has an effect on turbine efficiency due to supersaturation and moisture losses. The effect, however, is opposite to that of inlet pressure. When steam temperatures increase, moisture and supersaturation losses decrease, therefore turbine efficiency increases. Higher steam temperatures will also reduce steam

*Manager of Product Design, Small Steam Turbine Dept, General Electric Company

Steam Turbine Costs

consumption, by increasing the available energy.

Speed is also a factor which affects a turbine's efficiency. While the steam turbine is usually thought of as a machine whose efficiency improves with increased speed, it is nevertheless likely that units operating at comparatively high speeds may be slightly less efficient than those designed for somewhat lower speed operations.

Reduction in efficiency, because of high speed, can be explained as follows: The number of stages used in high speed turbines is determined by cost, desired efficiency level, and mechanical considerations such as stress and critical speeds. Usually higher speed turbines will have fewer stages than turbines of lower speed.

Reheat Factor Contributes

One of the factors in the overall efficiency of a multi-stage turbine is an effect known as the reheat factor. Since a turbine stage is not 100 per cent efficient, some of the heat energy not absorbed by that stage is available to do work in succeeding stages. Because of this, it is known as the reheat factor. This factor is of greater benefit in a turbine of many stages than in a turbine of few stages.

High-speed turbines are also limited in their efficiency by the mechanical considerations which necessarily apply to the buckets mounted on the peripheries of the wheels. As the steam passes successively from stage to stage through a turbine, the corresponding decrease in pressure must be accompanied by an increase in volume. This necessitates increased nozzle and bucket areas in each succeeding stage to pass the steam flow.

Therefore, for the latter stages of a condensing unit, these buckets should become comparatively large in order to pass the necessary flow. However, at high speeds it often becomes necessary or advisable to limit the length of these buckets in order to insure reasonable stresses. In terms of efficiency, these shorter buckets result in steam velocities at the exit side of the wheel which are greater than optimum, for increased steam velocity represents energy from which useful work was not extracted.

Lower Initial Costs

Slightly lower efficiencies of high-speed turbines are offset by lower initial costs. While it is true that each stage of a high-speed turbine is more costly than a stage of a moderate speed unit, the lesser number of stages results frequently in a lower initial cost. We should also not lose sight of the fact that high speed results in significant reduction in size of both the turbine and its driven equipment, and possibly even in the cost of the driven equipment.

Costs Presented Graphically

To illustrate graphically how steam conditions and speed can affect turbine economics, Figs. 2, 3, and 4 were prepared. These curves can be used to obtain the combined costs of purchasing a mechanical drive turbine, and operating it full load for a period of three years, for 90 per cent of the total available time. Fuel costs are assumed to be 25 cents per 1,000,000 Btu and boiler efficiency of 85 per cent. The charts may therefore be used to help in selecting the most economical steam conditions and turbine speed, provided that operating periods and fuel costs are as indicated in Fig. 2.

Figure 2 shows a plot of investment cost plus operating costs divided by horsepower (dollars/horsepower) versus horsepower rating, when steam conditions, operating period, and fuel costs are as indicated. These combined costs were calculated using data for turbine selling price and efficiency which are representative of industry at the present time. It should be noted that the cost

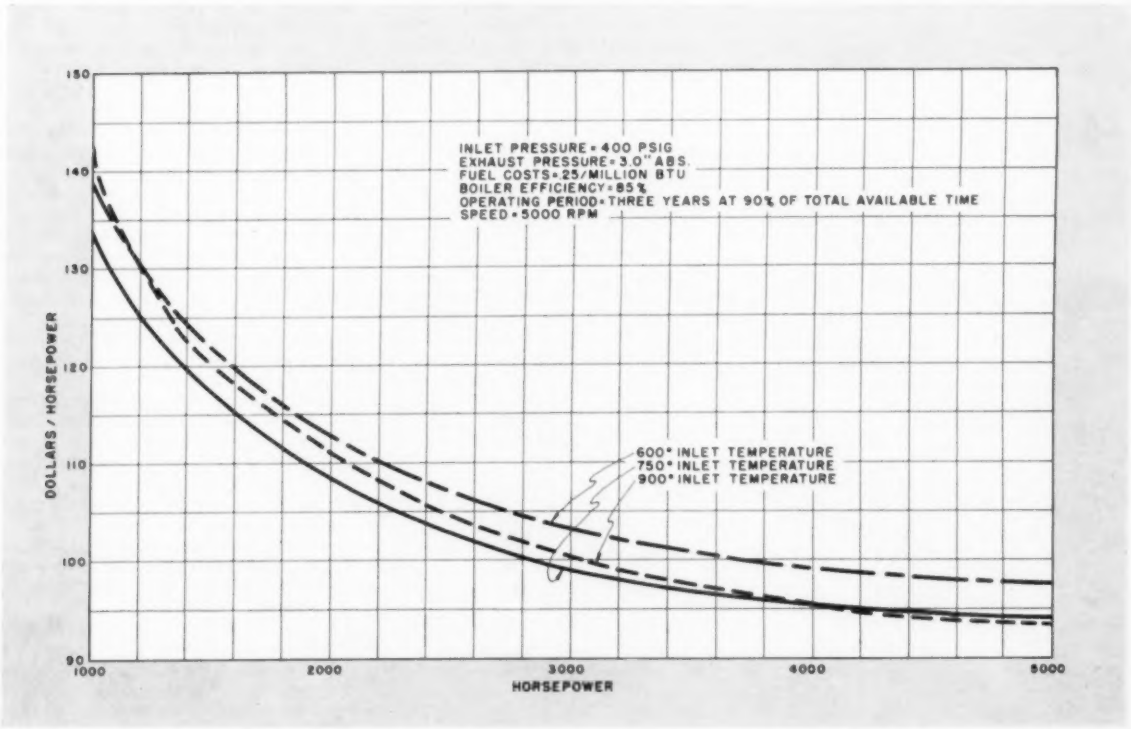


Fig. 2. Investment cost plus operating cost in dollars horsepower for condensing units plotted against horsepower ratings

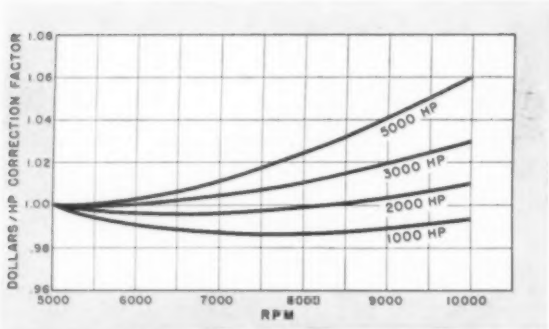


Fig. 3. Dollars/horsepower correction factors versus speeds

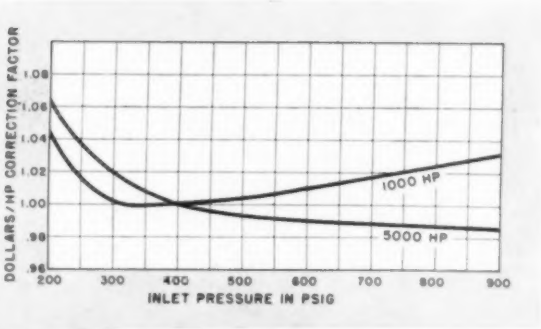


Fig. 4. Dollars/horsepower correction factors for pressures

per horsepower decreases as the rating increases. This is the result of both higher turbine efficiencies and lower incremental manufacturing costs which occur as units get larger.

It should also be noted that Fig. 2 can be used to obtain the most economical turbine inlet temperatures. Below ratings of 4000 hp, this will usually be 750 F, because above this temperature, more expensive materials and construction are required.

Since these curves are based on only one inlet pressure (400 psig) and one speed (5000 rpm), Figs. 3 and 4 have been prepared so that combined investment and fuel costs can be obtained for other inlet pressures and speeds.

As Speed Increases

From Fig. 3 we can obtain a dollars per horsepower correction factor for speed. When this factor is multiplied by the dollars per horsepower obtained from Fig. 2, we have calculated the combined investment costs and operating costs for speeds other than 5000 rpm. It can be seen that as ratings and speeds go up, the cost in dollars per horsepower also goes up. This is largely the result of the lower turbine efficiency of high-speed turbines. The lower turbine efficiency increases the steam consumption and therefore the fuel costs.

It should not be assumed, however, that high speeds for mechanical-drive turbines are not economical. High speeds become economical: 1, when fuel costs are low; 2, when the cost of the driven equipment is reduced due to lower initial costs or improved efficiency; or, 3, if turbines operate non-condensing with shorter last stage buckets than a condensing turbine, which greatly reduces stress problems. Figure 3 does indicate, however, that care should be exercised in the selection of a speed, particularly at the larger ratings.

For inlet pressures other than 400 psig, combined costs in dollars per horsepower can be calculated, using the correction factors obtained from Fig. 4. From Fig. 4, it can be seen that inlet pressures greater than 400 psig are more economical only for turbines of higher ratings. The gain, however, is small and it will probably be difficult to justify steam pressures greater than 600 psig because of higher boiler costs and piping costs.

When steam pressures approach 200 psig and less, there is a sharp upturn in turbine costs, as indicated by the curves. This can be explained as follows: When steam pressures decrease, there is a corresponding increase in steam volume per lb of steam and a decrease in the available energy per lb of steam. The increased steam volume requires larger and sometimes special construction inlet parts which raise turbine costs. The lower available steam energy results in more steam flow being used by the turbine, to develop the desired horsepower. At lower steam pressures therefore, turbine costs go up along with fuel costs.

Effect of Exhaust Pressure

Condensing mechanical-drive turbines usually operate at approximately 3.0 in. Hg abs because of limitations in cooling capacity at industrial sites. However, units with condenser pressures as low as 2.0 in. and as high as 4.0 in. do appear. Therefore an exhaust-pressure correction curve appears in Fig. 5.

When condensing exhaust pressures are 2.0 in. Hg abs or 4.0 in. Hg abs the dollars per horsepower correction factor can be obtained from Fig. 5. The condensing exhaust pressure will affect economics in the following manner: Lower exhaust pressures mean more available energy per lb of steam, and lower fuel costs. Turbine costs on the other hand will increase, because the higher specific volume of lower exhaust pressures will require larger exhaust hoods and last-stage blade heights.

It is true as well that for higher-speed machines, where last-stage blade heights become limited, lower exhaust pressures will also result in lower turbine efficiencies. This is due to the increased steam velocity at the exit side of the wheel, caused by the higher specific volume. Each of these items will somewhat offset the potential fuel savings at lower exhaust pressures.

When higher condensing exhaust pressures are used, this will result in greater fuel costs and lower turbine costs. There will also be an improvement in turbine efficiency at the higher speeds. The correction factors appearing in Fig. 5, therefore, should

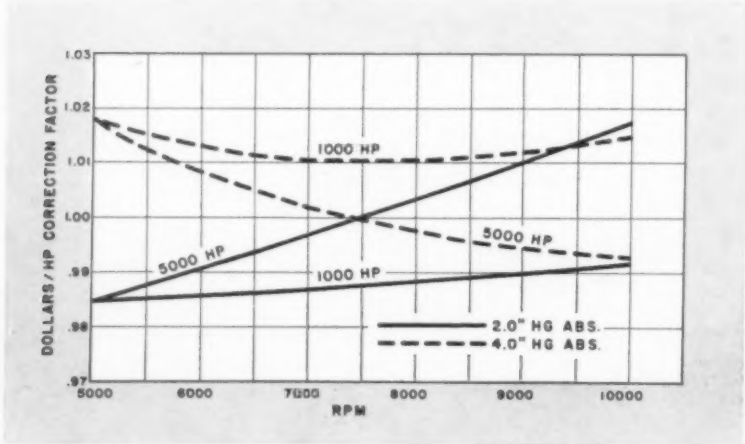


Fig. 5. Dollars/horsepower correction factors plotted against exhaust pressures

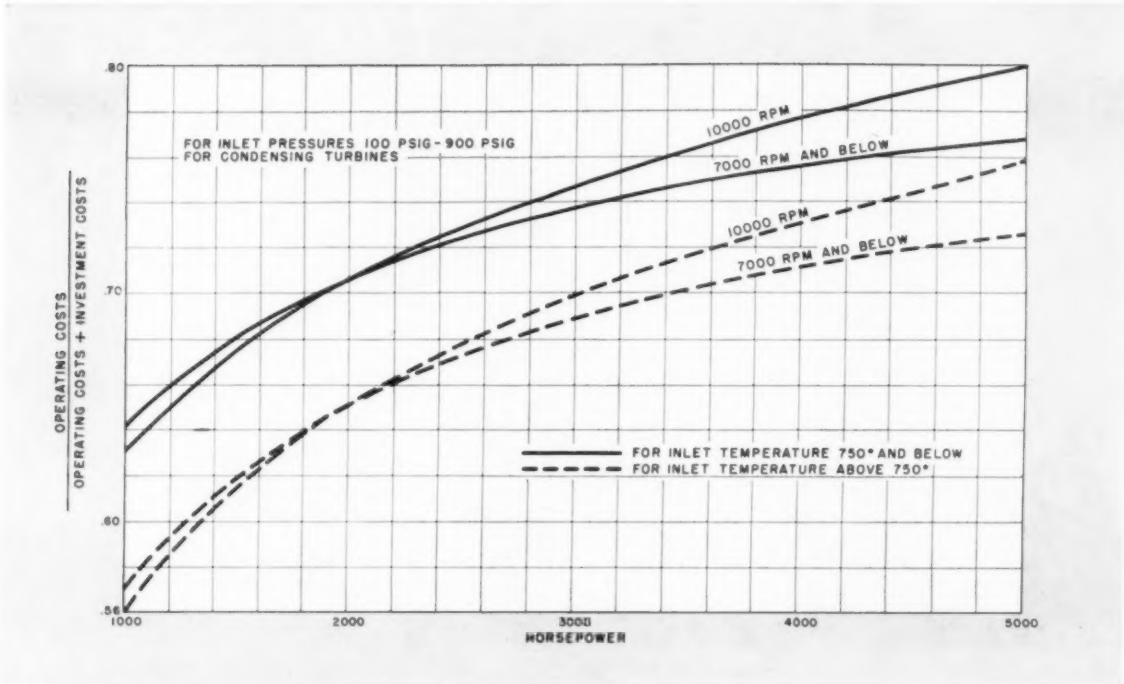


Fig. 6. Ratio of operating costs to operating costs plus investment costs versus ratings. Interpolate intermediate speeds

be very helpful in selecting a condensing exhaust pressure. It should be noted, however, that only turbine and fuel costs have been considered. The cost of condensers, piping, and cooling tower capacity will also be factors to consider in selecting exhaust pressures.

Obtaining Operating Costs

When fuel costs and operating periods are appreciably different from that shown in Fig. 2, combined costs in dollars per horsepower can be computed with the aid of Fig. 6. On this chart is plotted a ratio of operating costs over combined operating costs and investment costs, when the operating period is three years, and fuel costs are 25 cents per 1,000,000 Btu. With this ratio, we can separate operating costs from investment costs.

This can be done by first calculating the dollars per horsepower from the earlier figures. Then from Fig. 6, read the ratio of operating costs over operating costs plus investment costs for the proper speed and inlet temperature. When this ratio is multiplied by the dollars per horsepower, we have obtained operating costs, thereby separating operating costs from investment costs. Operating costs can now be adjusted, for they will vary directly as the fuel costs per 1,000,000 Btu and the length of the operating period.

For example, if fuel costs are 50 cents per 1,000,000 Btu instead of 25 cents, and the operating period is four years instead of three, operating costs can be adjusted by multiplying by two and by four thirds. By adding the adjusted operating costs to the investment costs, a corrected value of dollars per horsepower has been obtained.

In the above case it will be observed that the operating cost varies directly as the fuel cost. This is an approximation based on the assumption that the fuel cost is by far the major share of the operating cost. Maintenance, attendance and other costs are not included in these studies.

It should be noted from Fig. 6 that operating costs exceed investment costs even in the low ratings. Operating costs can become as high as 80 per cent of the combined costs at ratings of 5000 hp. When fuel costs are appreciably higher than 25 cents per 1,000,000 Btu, and the operating period is longer than three years, this percentage will become even higher. For those cases, economics will tend to favor turbines operating at lower speeds and steam conditions with higher available energies.

Typical Turbine

To illustrate the use of these graphs, the following example has been prepared. What are the combined investment and operating costs of a 4500 hp mechanical-drive turbine, when steam conditions are 600 psig, 750 F, 3.0 in. abs and the turbine speed is 8000 rpm? Fuel costs are 40 cents per 1,000,000 Btu, the operating period is five years, for 90 per cent of the total available time, and the boiler efficiency is 85 per cent.

From Figs. 2, 3, 4 and 5:

Dollars/Horsepower = $94.50 \times 1.02 \times 0.994 \times 1.00 = 95.70$

From Fig. 6:

$$\frac{\text{operating costs}}{\text{operating costs + investment costs}} = 0.772$$

Operating costs = $0.772 \times 95.70 = 74.00$

Investment costs = $95.70 - 74.00 = 21.70$

Corrected operating costs = $74.00 \times \frac{40}{25} \times \frac{5}{3} = 197.00$

Corrected dollars/horsepower = $197.00 + 21.70 = 218.70$

Combined investment and operating costs = $218.70 \times 4500 = \$985{,}000$

For this same example, combined investment and operating costs can be calculated for other steam conditions and speeds. In this manner, a direct comparison can be made, for the purpose of determining the most economical speed and steam conditions. THE END

WOULD YOU LIKE TEAR SHEETS?

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Fig. 1. Pneumatic torque-controlled wrenches used for tightening. Two-man team average 177 fasteners per day

Fig. 2. Torque is set twice daily with device that measures tension. This assures a rigid joint and reduces inspection

High Strength Bolting Speeds Boiler Erection—Cuts Costs

By L. W. DONNELLY *

SUBSTITUTING 20,633 high tensile bolts for rivets in the erection of a new boiler structure for the first 165,000 kw unit at the Smithers Lake Steam Station of Houston Lighting & Power Co, cut direct labor costs on fastener installations 63 per cent. Over-all fastener costs were cut 18 per cent, and the use of bolts also resulted in a shorter erection time.

An identical installation begun several months previously at the power company's Sam Bertron Station was riveted. But Ebasco Services Inc, who is handling the engineering and construction, recommended bolting for the Smithers Lake work.

Since the Sam Bertron and Smithers Lake boiler installations were identical, Ebasco, who has recommended bolting on a number of power plant installations, kept close tabs on costs and labor time on both jobs to obtain an accurate yardstick of the advantages of bolting over riveting.

Both installations were Combustion Engineering 1,200,000 lb per hr reheat cycle gas or oil fired steam generators. The supporting steel for each required 20,633 field fasteners. An analysis of the two jobs showed that one four man riveting team at the Sam Bertron Station installed an average of 131 rivets in an eight hour day (4.1 per man-hour), while one two-man bolting team at Smithers Lake averaged 177 fasteners per day (11.1 per man-hour). On this basis, the Sam Bertron direct cost per fastener was approximately $2\frac{1}{2}$ times that for the Smithers Lake Station.

Total savings in direct labor costs were about $12,000. After deduction of the additional cost of the bolts, washers and nuts as compared to rivets — about $8500 — net savings totaled $3500.

Ebasco considers these savings typical for boiler erection work when bolts are used. Russell, Burdsall & Ward Bolt and Nut Co, whose high tensile bolts were used in the erection of the Smithers Lake boiler structure, reports similar savings on other types of steel erection.

Although the practice of bolting steel structures attained its initial popularity because of the nation-wide shortage of skilled riveting crews, the economic advantages are accelerating the trend. RB&W estimates that over 50 per cent of all steel structures are now bolted.

High tensile bolts, identified by three radial dashes on each head are made to material specifications of ASTM A325 and dimension specifications of ASA B18.2. In erection work they are used with hardened, carburized washers and heavy nuts. Although actually stronger than rivets, they are currently substituted on the basis of one bolt for one rivet. Standards organizations are conducting research to determine the exact degree of the superiority of the bolt over the rivet so that standards may be changed to permit fewer fasteners.

A joint fastened with high strength bolts is clamped together by tension in the bolts. All stress is transmitted to the joint members by friction on the contact surfaces. In a riveted joint rivets shrink in post-installation cooling to provide an indefinite amount of clamping force. Control of this pre-load tension in a fastener is more difficult to obtain and impossible to check in a riveted connection and stress in joining members may be transmitted by shear on the rivets.

Correct pre-load tension is obtained in bolted joints by use of controlled torque wrenches. When properly calibrated they assure proper bolt tension. At the Smithers Lake project *continued on page 112*

* Construction Manager, Ebasco Services, Inc.

Simple and Inexpensive Coal Sampler Automatic In Operation

Power Engineer develops automatic coal-sampling device that attaches to existing car-to-hopper conveyor. Simple components used to assemble equipment which operates when coal belt runs

By A. H. GESELL *

FOR MANY years, our only approved method of coal-sampling was the Stuckenberg system, which employs the use of a heavy standard measuring unit. This measure weighs 55 lb, and is cumbersome and hard to handle. Normally, two men are required to lift the device, and the time required to obtain a good sampling is about one hour. Also, unless carefully supervised, the men assigned to the sampling job were inclined to take their samples by simply grabbing a bucket of coal from the top of the carload.

To overcome the difficulties mentioned, and to assure accurate sampling, we have developed an automatic device for attachment to our existing coal-handling equipment. The human element has been removed, and a uniform sample must necessarily come out of every car.

Heart of this simple but effective sampling device is a small screw conveyor, 3 in. in diameter, and 12 in. long, which is inserted into the discharge hopper of the apron conveyor. The actual length of screw which sticks into the hopper is 9 in.; this proves to be enough for obtaining uniform sampling. The screw is driven by a fractional-horsepower motor and a speed-reducer which turn the screw at 3.59 rpm; thus producing 200 cubic inches of sample from a 50-ton car of coal.

The sample of coal obtained by the small screw-conveyor discharges into a $1\frac{1}{2}$ in. by $1\frac{1}{2}$ in. metal chute. The chute empties the sample of coal into a miniature hammer-mill, where the coal is crushed to proper size. At the bottom of the hammer-mill is a small hopper in which there are twelve vertical divider battens; these divide the crushed coal into equal portions. From one of the vertical compartments, a second small chute leads to a glass Mason jar; this is the final sample for the laboratory analysis.

This small hammer-mill is driven by a $\frac{1}{4}$-hp motor, which operates the mill at 2000 rpm; this is sufficient power to crush the small amount of coal to proper size for analysis. The electric controls on the screw conveyor and the hammer-mill operate in conjunction with those of the regular coal-handling equipment; therefore, when the coal belt is operating samples are being obtained. Figure 1 is a sketch of the hammer-mill used in this application; it was fabricated in the shop, but similar mills are available on the market.

Costwise, this sampling device operates for about *eight cents per car* of coal sampled, compared to *four dollars* under the conventional methods. Our annual consumption of coal amounts to some 14,000 tons; for this amount, the new sampling device will save us about $1100, which is well worth going after. Cost savings in sampling is not the most important item, however. Obtaining uniform samples of each car provides a cost control which is absolutely essential to the maintenance of good plant efficiency. THE END

* Utilities Engineer

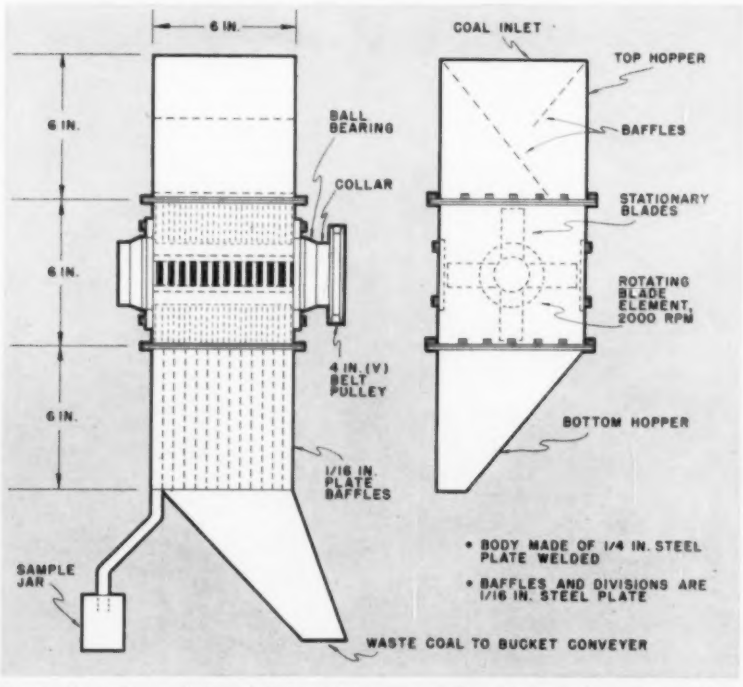


Fig. 1. Two views of shop-fabricated hammer-mill used to crush coal sample to proper size for chemical analysis. Note vertical separators in bottom hopper; these automatically provide proper sample portion. Mill is driven by a ¾ hp motor

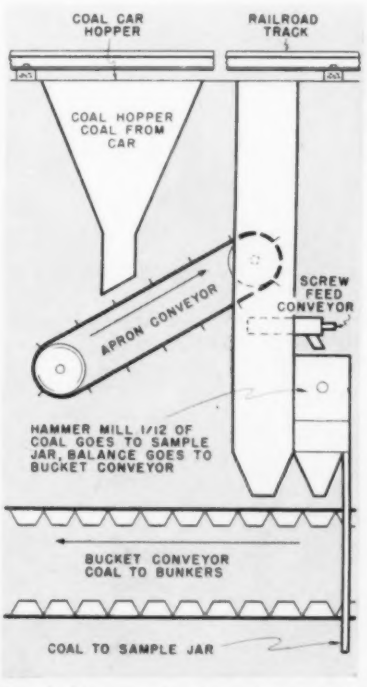

COAL CAR HOPPER
RAILROAD TRACK
COAL HOPPER COAL FROM CAR
APRON CONVEYOR
SCREW FEED CONVEYOR
HAMMER MILL 1/12 OF COAL GOES TO SAMPLE JAR, BALANCE GOES TO BUCKET CONVEYOR
BUCKET CONVEYOR COAL TO BUNKERS
COAL TO SAMPLE JAR

Fig. 2. Diagram showing relative positions of screw-conveyor sampler, hammer-mill and plant coal-handling units

Boiler Water Treating Systems

Factors to be considered in the selection of water treating equipment. A review in two parts . . . Part 2

[By T. L. PANKEY

LAST MONTH we began this discussion by presenting the essential facts about the basic cycles available for treating boiler feedwater. We described the sodium zeolite method, hot process lime soda, hot lime-hot zeolite, and had turned to demineralization.

As we said then, demineralization (see figure) is the newest and most rapidly developing cycle of water treatment. In it, calcium, magnesium and sodium are exchanged for hydrogen, and the chlorides, sulphates, bicarbonates and silica are exchanged for hydroxide with a combination of the hydrogen and hydroxide in the effluent to produce a pure water. Practically speaking, no chemical reaction can be carried to absolute completion, so there will be a small residual amount of dissolved solids in the effluent.

It is easily possible, however, to limit this amount of residual solids to 5 ppm or less with silica at 0.02 ppm. It can be seen that the jump upward in quality of water produced is very sharp and marked. Due to the high cost of the materials used, expense in initial investment and operation is high.

While demineralization is theoretically applicable to all types of boiler operation, in practice the use of demineralization is limited to applications where the cost of the high quality water is justified. Also, there is a practical limitation in the use of demineralization equipment as the total dissolved solids in the raw water increases. There comes a point in the operation of demineralizers, with increased total dissolved solids in the raw water, where the equipment will finally produce only about the amount of water required for use in regeneration. Long before this point is reached the cost of operation will become excessive. Complete study of all factors involved is necessary

Boiler Types and Water

Power plants operating in the range of steam pressures up to 250 psi have been considered easy to operate with relatively simple water treating equipment. A few years ago that conclusion would have been correct. At that time a low pressure boiler was a Stirling or straight tube boiler with large tubes and drums mounted in a refractory setting with heat transfer largely from hot gases passing around the tubes in a path directed by baffles.

In comparison with the low pressure boilers of past days a new low pressure boiler is very likely to have small tubes arranged to a great extent as water wall tubes subjected to radiant heat, with high transfer rates. In fact, some low pressure package boilers being sold today are practically flash boilers. This situation dictates the use of treating equipment which will produce a water of practically zero hardness, at least within the range of 1 or 2 ppm obtainable by effective zeolite softening.

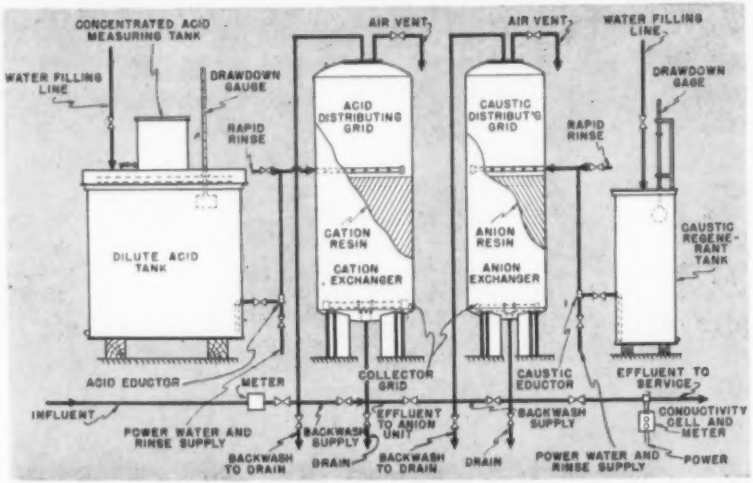
Many engineers can point out low pressure installations operating satisfactorily with a hot process lime soda softener or with some proportion of raw make-up water having a high hardness. In view, however, of the modern trend in types of boiler construction it would be extremely unwise to purchase new water treating equipment which would not produce a water of 1 to 2 ppm hardness. With the high rates of heat transfer being employed today, excessive amounts of deposits in the boiler would be very apt to occur if the feedwater had any appreciable amount of hardness.

Even if a low pressure boiler can be operated for reasonable periods with this considerable hardness in the entering feedwater, it will almost invariably be found that maintenance cost for turbining tubes and cleaning boilers could be greatly reduced by using a very low hardness feedwater and the saving would justify the increased expense in water treating equipment. In these low pressure boilers silica will rarely be a prime consideration, but alkalinity will be of extreme importance.

High alkalinity in the feedwater will not only result in high blowdown to maintain the proper proportion of alkalinity to total solids in the boiler, but also most low pressure boilers are required to furnish considerable quantities of heating and process steam which will later be returned to the boiler in the form of condensate. If alkalinity in the treated water is high, there will be a very large quantity of carbon dioxide in the steam and on condensation this carbon dioxide will form carbonic acid and cause return line corrosion.

Which Treatment When

If the raw water alkalinity is less than about 50 ppm, it will be possible to use straight sodium zeolite softening. If the alkalinity is over 50 ppm, sodium-hydrogen zeolite softening can be used effectively. Alternatively, hot lime-hot



Newest cycle of treatment is demineralization. In practice this is limited to applications where cost of high quality water is justified. The method is limited also by the amount of total dissolved solids in the water

*From a paper given at the annual meeting of NAPE in 1957. Mr. Pankey is associated with the Allis-Chalmers Mfg Co.

POWER ENGINEERING HANDBOOK

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How to draw the line on ashpit maintenance

zeolite softening is very satisfactory. The balance of decision between sodium hydrogen zeolite softening and hot lime-hot zeolite softening will lie in consideration of the character of the raw water available and the cost of treatment. The hot lime-hot zeolite process is preferred by many because of less maintenance, lower operating cost, and freedom from problems in handling acids.

In the range of 450- to 900-psi boiler operation, all of the problems found in lower pressure operation will be greatly aggravated. In particular, silica content of the feedwater will become a much more important consideration both from the point of view of its effect in forming boiler deposits and its influence in causing silica deposits in turbines, since silica becomes volatile in high temperature steam.

As boiler temperatures increase, silica begins to appear in the steam in increased quantity at about the saturation temperature of 400-psi steam. Sodium zeolite softening or sodium-hydrogen zeolite softening can be considered only if the initial silica in the water is extremely low. It will more generally be found that some silica reduction will be required. Obviously, it would be desirable to have the very high quality water secured by means of demineralization. If the percentage of make-up is relatively low, it may be possible to employ demineralizers without excessive cost. It has been found that the hot lime-hot zeolite process, which will produce satisfactorily low silica, low hardness, and low alkalinity, is extremely useful in boiler plants with pressures as high as 900 psi and with 100 per cent make-up.

In plants operating above 900 psi either in industrial cycles or in central stations, the quality of water produced by demineralizers is a practical necessity. In this range evaporators are used to some extent, but are largely being supplanted by demineralizers.

These recommended applications for water treating cycles are based on the assumption that there will be substantial percentages of treated make-up water fed to the boiler. If make-up percentage is low, it may be possible to use less expensive water treating equipment, or preferably to take advantage of the smaller sizing and use better equipment. When making additions to existing plants, size of equipment and space available may become a dominant factor.

It will have been noted that this discussion hardly touched upon the physical details of various types of equipment. This was due not only to limitations of space, but to the desire to emphasize the fact that the actual equipment can be selected only after thorough study of available water sources, steam generating conditions, and after selection of the basic water treating cycle.

Newest Electronic Troubleshooters

AN IMPORTANT and growing category of electronic devices is known as "troubleshooters," the *Bureau of Ships Journal* reports. The new devices in this group automatically detect unsafe conditions on board ship.

Enlisted personnel used to stand watch and take instrument readings; now electronic troubleshooters have the duty. Their sensing elements are designed to detect abnormal conditions immediately and to flash or buzz warning signals. These have many uses:

Some sense excessive temperatures and sound a fire alarm. Others detect explosive vapors and send out a warning call. Others indicate that a dangerous amount of water is contaminating fuel. Still others show when the salt content of water is so high that it may damage the boilers. One device informs a submarine crew when a hatch has been accidentally left open.

A typical new development among the troubleshooters is a bearing temperature monitor, designed to keep constant check on the temperature of significant bearings in several machines at the same time. When a bearing overheats, the monitor is designed to flash or buzz a warning to engineroom personnel.

This device monitors 40 bearings at once. Its small, simple, rugged design was made possible through the use of thermistors (heat sensors) and transistors which are tiny electronic valves.

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Fig. 1. Overhead 3-in. plug valve in antibiotics plant is operated by quarter turn of wrench

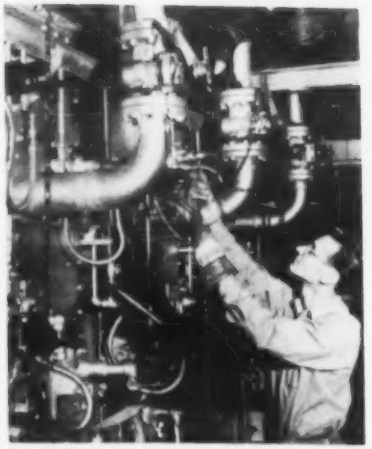


Fig. 2. Small 1-in. lubricated plugs used as gas cocks on front-fired boilers in chain operation

Hard-to-Reach Valves? Here are 4 solutions

Based on quarter-turn action of lubricated plug valve

Rockwell Mfg Co

Fig. 3. Small wrench operates this valve in products distribution system from full open to closed

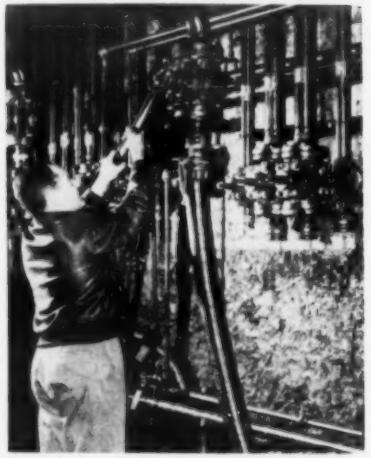
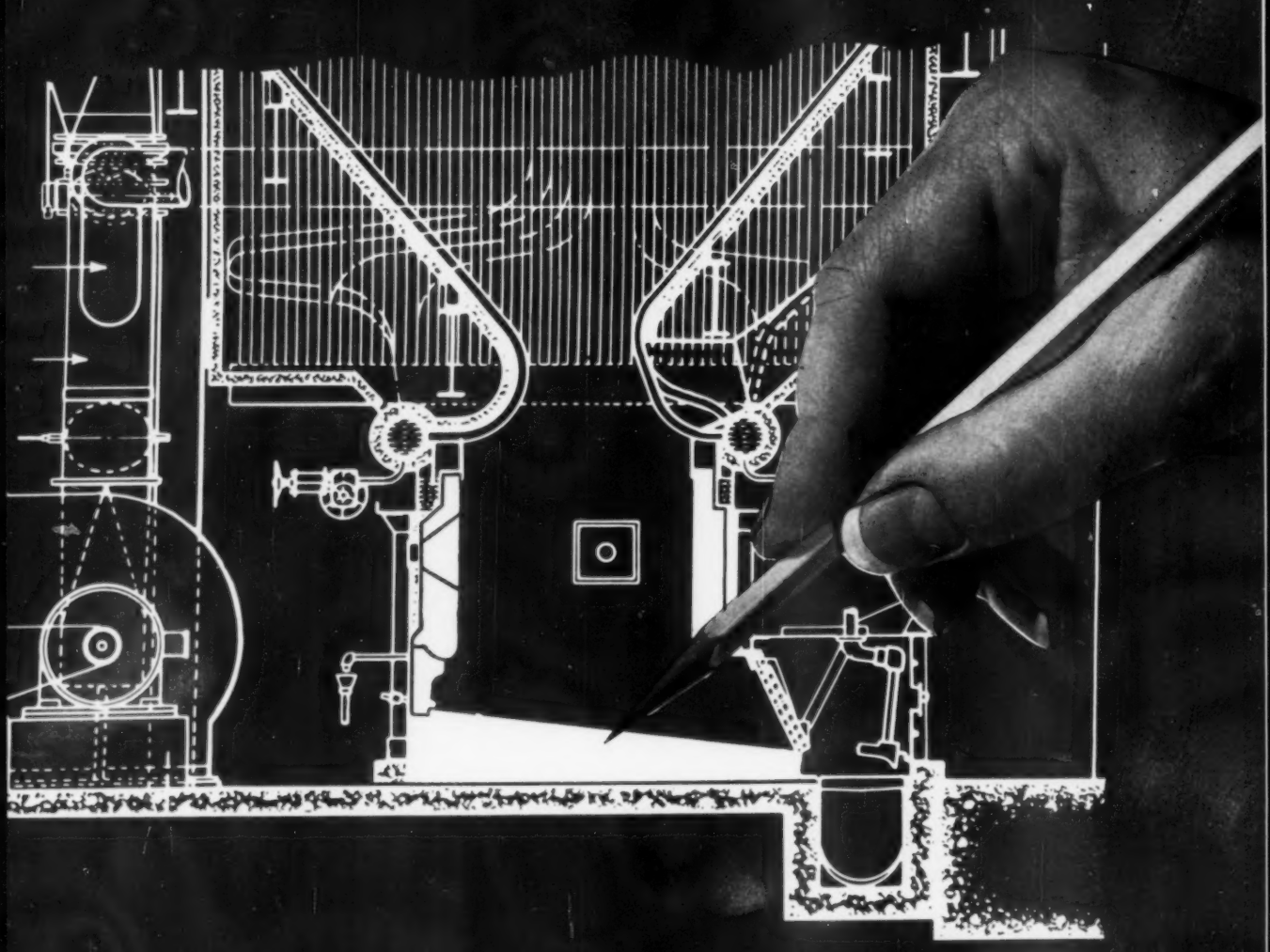


Fig. 4. Underground valve is equipped for operation from ground level by high stem extension

cut along this line

How to draw the line on ashpit maintenance



"Let's put Kaocrete here"

Relining ashpits is expensive and time-consuming. That's why more and more utilities and industrial companies are specifying a heavy-duty refractory castable such as B&W Kaocrete D. On job after job, it has withstood the heavy abrasive or erosive attack of sprays, jets, rakes or shovels.

The reason? Specially designed Kaocrete D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It saves time because it can be poured or gunned into place. For less severe abrasive or erosive conditions, B&W recommends Kaocrete A.

Get the facts and figures on these B&W Refractory Castables from your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

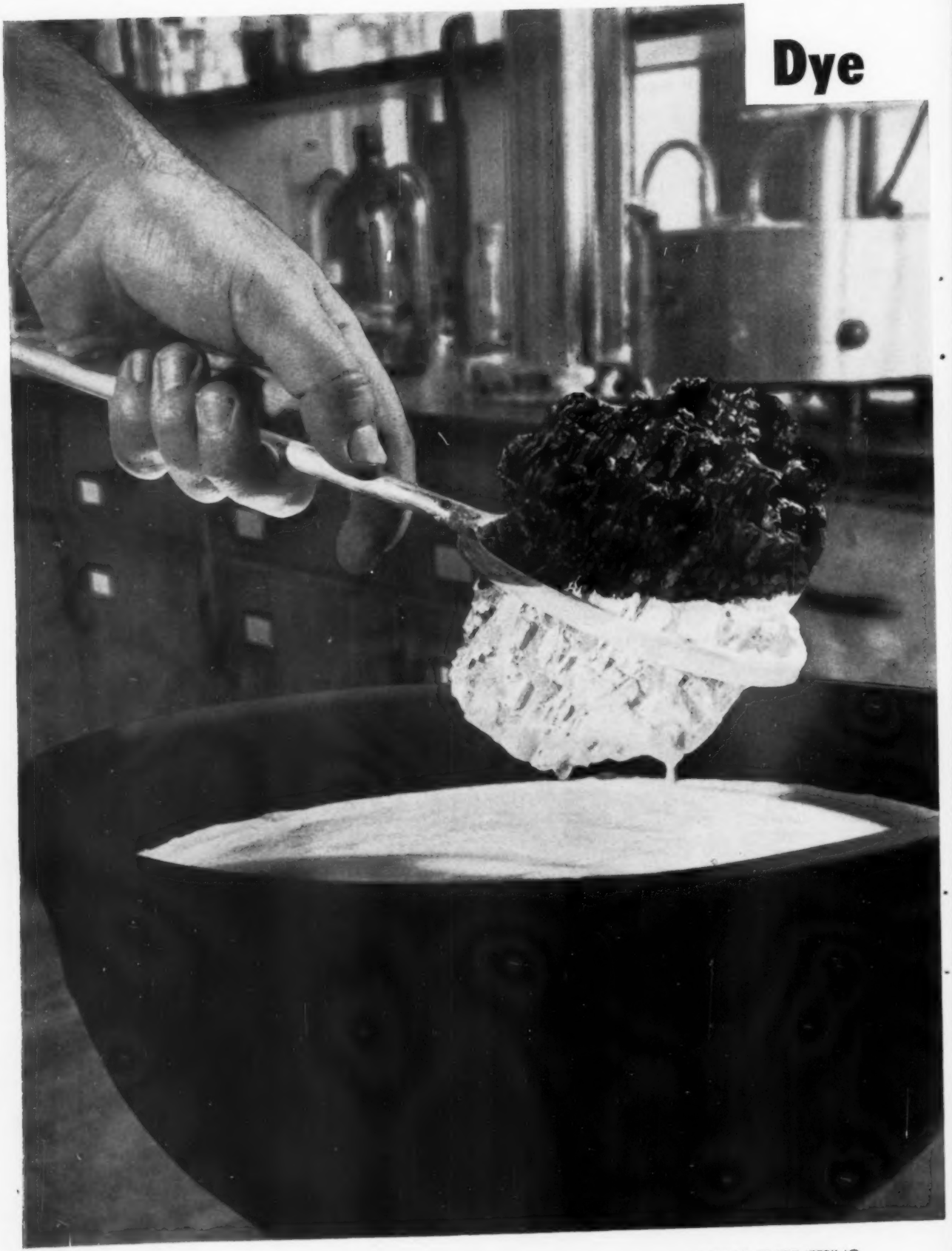
BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

R-540

For more data circle 541 on Post Card


Dye

maker brightens fuel cost picture

Burning coal at Toms River-Cincinnati saves 20% on fuel costs, permits clean steam generation

The Toms River-Cincinnati Chemical Corp. plant in Toms River, N.J. is the most modern plant of its kind in the world. Producing vat dyestuffs requires a large dependable steam supply for chemical processes and heating purposes. To fill these requirements, the power plant at Toms River-Cincinnati is as up-to-date and efficient as the general plant itself. The fuel used for steam generation is *coal* because, on the basis of cost per thousand pounds of steam, the nearest competitive fuel costs 20% more than coal. In addition, thanks to automatic operation and modern equipment, the power plant meets the rigid standards of cleanliness required in such manufacturing operations.

Facts you should know about coal

Not only is bituminous coal the lowest-cost fuel in most industrial areas, as in the case of Toms River-Cincinnati, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment pares labor costs and eliminates smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

The Bituminous Coal Institute offers a free technical advisory service on industrial fuel problems. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—will effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

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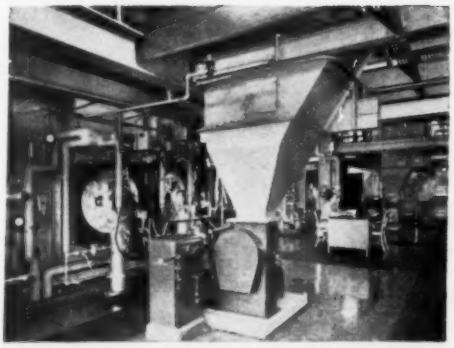
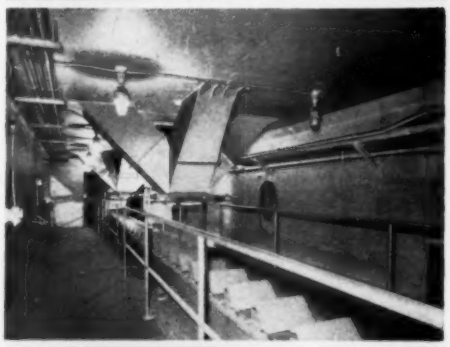
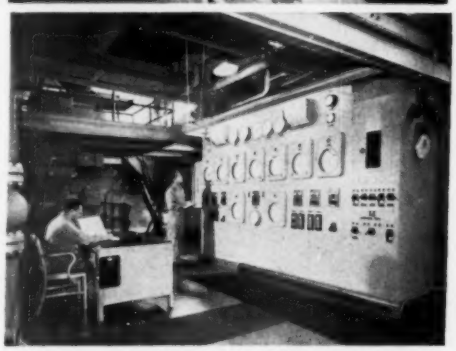


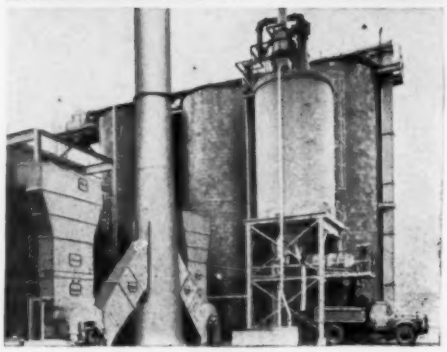
View of boiler room showing both 50,000 lbs. hr. boilers, by Riley Stoker Corp. Each has two burners. Center foreground is automatic weigh scale, by Richardson Scale Co., which receives coal through hopper from live storage bin and passes it to coal feeder. Coal is fed to Riley Pulverizer in basement, then blown back up to burners.



Close-up of Gifford-Wood Roundabout Bucket Conveyor beneath coal storage silos. Transversing feeder-car is used when coal is emptied from silo and conveyed to live storage bin.



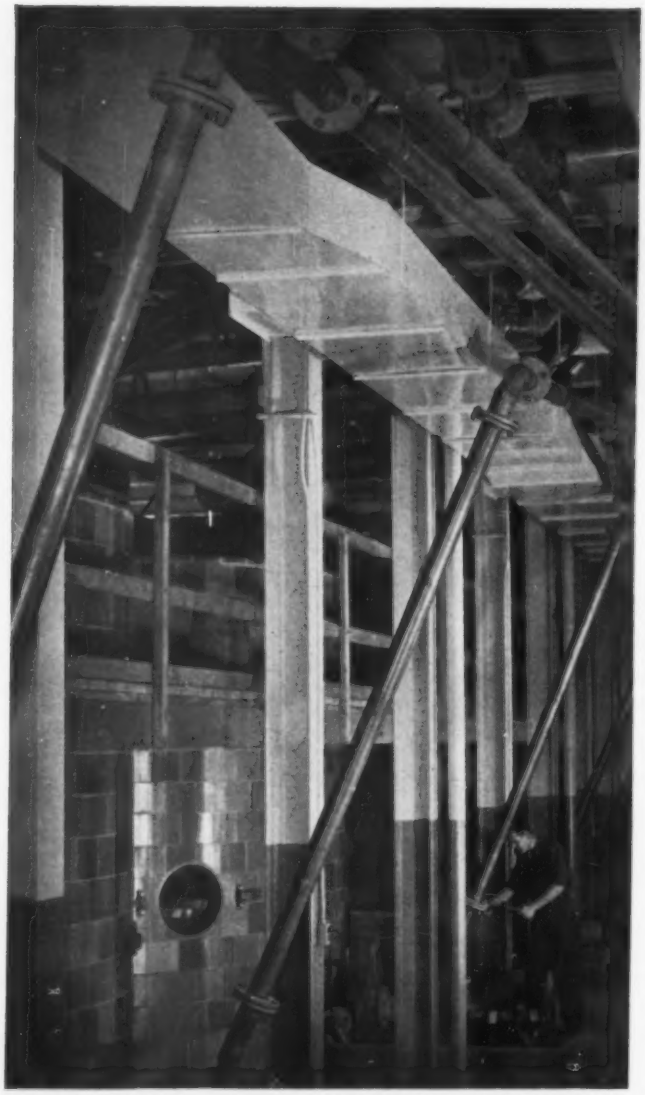
Automatic combustion control and instrument panel by Bailey Meter Co.



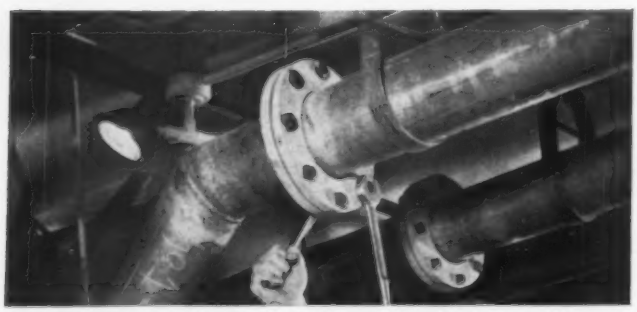
Fly ash being loaded on truck through a dustless rotary unloader. Fly ash is collected by Prat-Daniel Mechanical Precipitators. A pneumatic ash collecting system by United Conveyor (with tie-ins under air heater and at base of stack) removes it to this 20-ton ash silo. In the rear are three 330-ton coal silos.

For more data circle 595 on Post Card

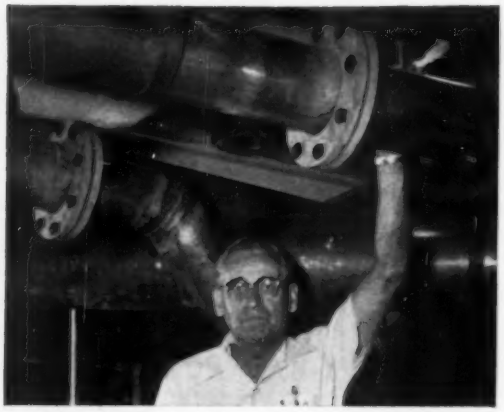
Copper tube for pipe lines cuts installation time 40% —gives superior service in paper pulp handling



COPPER TUBE USED to transmit paper pulp in the Crocker, Burbank & Co., Mill #5 at Fitchburg, Mass.



LARGE-DIAMETER copper tubes are joined by welding (note elbow) or by the flange type of connection.



WILLIAM G. DUNN of Crocker, Burbank & Co. says copper tubes for the process lines in paper-making plants offer many advantages over other piping materials. He uses Anaconda Copper Tube in sizes up to 10" I.D.

"Easy handling and installation are the biggest advantages of copper tube in our operation," says William G. Dunn, supervisor of sheet metal and piping for Crocker, Burbank & Co., paper manufacturers of Fitchburg, Mass.

"We estimate that copper saves us about 40% in installation time. Just the advantage of standard 20-foot lengths greatly simplifies our job, when you consider that we have runs up to 365 feet long. Also, because of the relatively light weight of copper tubes, we can do more fabrication and preassembly in our pipe shop than would be practical with heavier piping."

Meets corrosion problems. Copper tube lines are used to transmit paper pulp from beaters to pulp storage tanks and on to work boxes at the paper machine. In this service, copper does not contaminate the pulp and resists corrosion from the pulp solutions. Copper tube is also used to carry deionized water used in the paper-making process.

Your requirements. No matter how special your piping problems may be, it is quite possible that Anaconda seamless tubes may provide the solution. The American Brass Company offers the widest range of sizes in copper and copper alloys available to industry—from .032" O.D. to 26.875" O.D. Technical assistance is also available to help you determine the alloy best suited to meet your requirements. For such help or further information about Anaconda products, contact our nearest District Sales Office or write to: The American Brass Company, Waterbury 20, Conn.

3790

ANACONDA®

SEAMLESS TUBES

in Copper, Everdur®, Cupro Nickel, Brass

Made by

THE AMERICAN BRASS COMPANY

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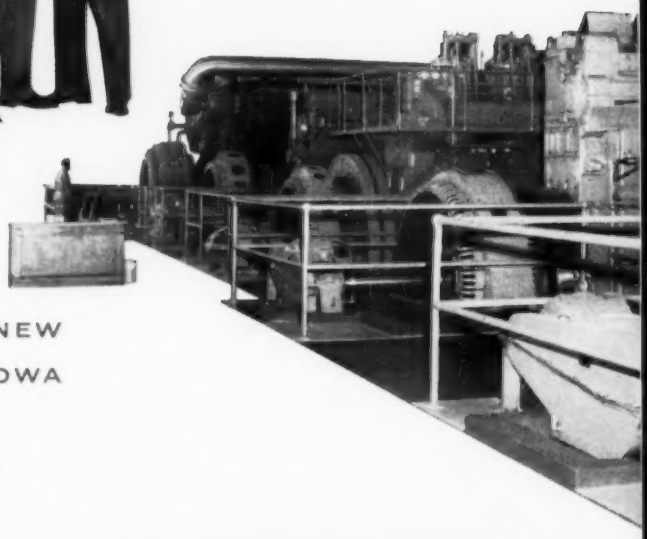
Maybe *you'll soon have this decision to make*



LUBRICATION CASE STORY ON THE NEW WORTHINGTON AT INDEPENDENCE, IOWA

Situation: Gene Williamson, plant superintendent, had a decision to make when the Independence, Iowa, Municipal Light Plant installed a new 3600 Horsepower Dual-Fuel Worthington last year. What lubricating oil to use? Other equipment in the plant was lubricated with STANODIESEL Oil M. Performance was excellent. Lubrication technical service performed by men with experience and training for the job likewise was excellent.

What was done: The decision was made to install STANODIESEL Oil M. Now after 3,780 hours of operation, there are no regrets. There are no signs of wear.

STANODIESEL Oil M is refined from the finest-quality base stock. Additives help the oil resist viscosity change, keep engine parts clean. Other additives control foam, make it possible for oil to reach and hold protective film on even the most difficult to lubricate parts.

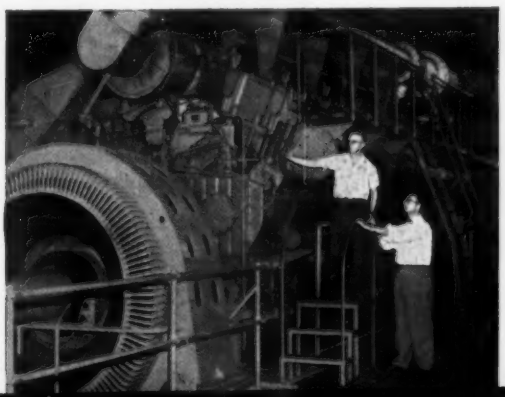
What you can do: Get all the facts about STANODIESEL Oil M from your Standard Oil lubrication specialist. There's one near you in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

Quick facts about

STANODIESEL OIL M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

You expect more from **STANDARD** *and get it!*



Running smoothly. Gene Williamson, power plant superintendent, and Standard Oil's Bob Wenger (right) check over new Worthington Dual-Fuel engine. Good lubrication technical service is one of the reasons Williamson decided upon STANODIESEL Oil M when engine was installed. Bob Wenger is well qualified by both experience and training to provide such technical service. He has been doing this work for nine years. In addition, he has an engineering degree from Iowa State and has completed the Standard Oil Sales Engineering School.

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 127–128 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—TITANIUM FITTINGS for nuclear, other critical piping

Developed to meet needs of nuclear piping systems and critical service in chemical processing industries, these titanium fittings offer savings in weight with increased resistance to corrosion and erosion, manufacturer announces, plus unmatched stability at high temperatures. The fittings are claimed practically impervious to attack by corrosive salts at moderate temperatures. They are also reported to provide greater latitude in tensile strength, fatigue resistance and ductility under a wide range of conditions. Property data is given in a booklet, "Titanium Moves Into Process Equipment." Ladish Co.

2—SPLICING KIT for making Y splices quickly

Scotchcast Splicing Kit 82-B1 is introduced to permit embedding tap or branch splices in epoxy resin. With this kit you can insulate Y splices in the field in less than 10 min, according to company, and once the splice has been

cast, it is permanently encased in a block of insulating resin which will remain solid and water-tight despite aging, heat and pressure. The kit consists of a two-piece plastic mold which snaps together around the wire, two plastic spouts for pouring the resin into the mold, strips of sealing tape for the mold joints and a Unipak container of epoxy resin. The kit will accommodate wires from $\frac{1}{4}$ to $\frac{5}{8}$ in. OD. Minnesota Mining and Mfg. Co.

3—STATIONARY BATTERIES for stand-by emergency power

These lightweight, space-saving stationary batteries are offered for switchgear, alarm system, control, emergency light and other applications where batteries are used as stand-by emergency power. Available over a capacity range from 40 to 960 amp/hr, the new line of Plante batteries is designed for full float service. A rugged Plastrite jar, lighter in weight than many containers, saves 30 to 40 per cent in floor space, it is announced, and the high impact resistant plastic will not bulge or warp under heat. Among construction improvements announced is a new pot seal which utilizes a soft rubber O-ring in compression to seal the post against possible seepage — to eliminate corrosion and wet covers. Gould-National Batteries, Inc.

4—BULKHEAD ADAPTER speeds panelboard installation

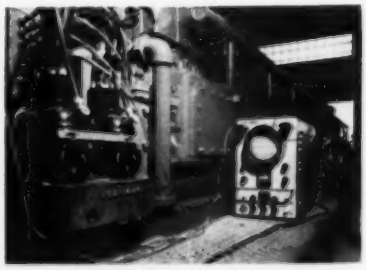
The Swagelok Bulkhead Adapter is designed to speed up and simplify panelboard installations. It can readily be installed for any desired combination of tube connections. Since the adapter can be used with standard fittings for rapid installation of tubing lines in any direction, special elbow unions or tube bending operations are not necessary, manufacturer notes. Space saving, of prime importance in panelboard installations, is an outstanding feature of the bulkhead adapter. A variety of tubing connections is possible within a limited space. It is available in machinable metals or plastics. Crawford Fitting Co.

5—ADDITIVE for diesel fuel oil, heavy bunker oil

For increasing operational efficiency of diesel and bunker C fuel oils, Kleen-Kombustion is fortified with a special concentrate and claimed to prevent formation of varnishes or gums, reduce sludge formation and keep piston ring grooves clean. Use of this additive is reported to result in increased power output and lower fuel costs, and to improve atomization and eliminate incompatibility of fuel oils. Heavy fuels retain much of the unrefined impurities in crude oil, it is pointed out, and insoluble residues often combine with moisture and fuel to form sludge. Kleen-Kombustion is said to prevent agglomeration and keep residual particles dispersed through the fuel oil so that they will pass through fine orifices or screen openings without clogging. A gallon of the additive is sufficient to treat 1000 gal of fuel oil, manufacturer states. Sudbury Laboratory.

6—ENGINE ANALYZER for low speed industrial units

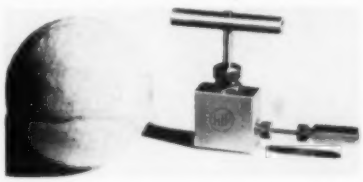
Secondary signal information, the unknown in system analysis on low speed industrial engines, can be viewed with the Du Mont Type 2662 Industrial EnginScope, it is announced. The instrument is said to be the only oscilloscope engine analyzer for spark ignited industrial equipment to feature a multi-line presentation, cylinder by cylinder. It is designed to locate troubles instantaneously in any spark ignited industrial engine, either magneto or battery type. According to manufacturer, the multi-line presentation allows a mechanic to pinpoint troubles by cylinder comparison. Each cylinder operation, from the firing of the spark to the points open, is shown on the picture screen, one line below the other in the firing order of the



engine. By using company's Signal-Clips on the harness, connecting the instrument can be done while the engine is operating. This method picks up the engine "pulse" through induction, making it unnecessary to disturb system. Allen B. Du Mont Laboratories, Inc.

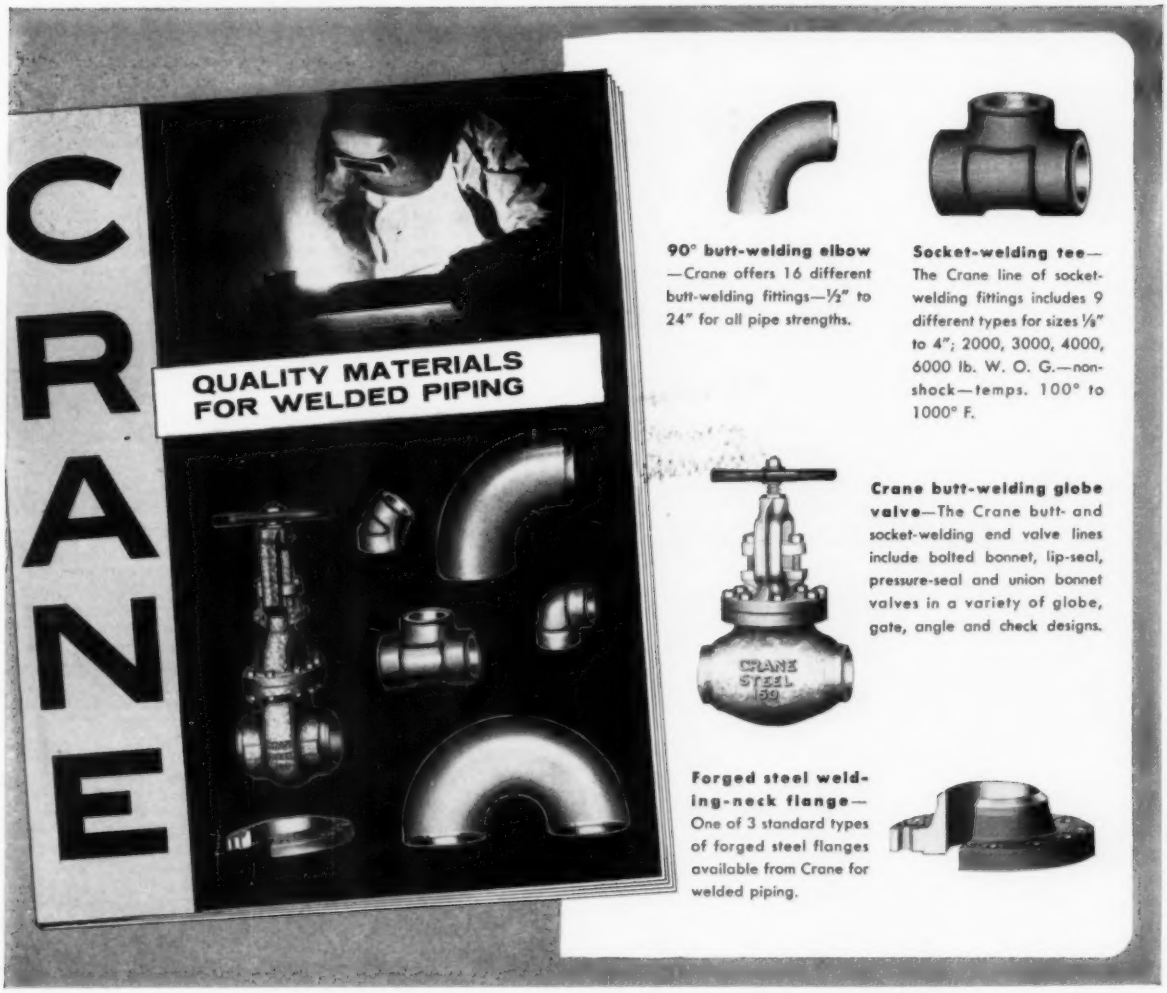
7—HIGH PRESSURE VALVE is extremely compact in size

Described as tiny enough to fit inside a tennis ball, this high pressure valve is designed for $\frac{1}{16}$ in. tubing and handles up to 15,000 psi. The stem is non-rotating type. Valve is available in stainless steel, Monel or Hastalloy and is adaptable for standard compression, socket weld and IPS connections. The capacity of the system, with a minimum of hold-up, is claimed ideal for gage lines, instrument, sampling and catalytic injection systems. High Pressure Equipment Co., Inc.



8—COMPACT BREAKER saves on mounting space

This compact 100-amp molded case circuit breaker, the EH frame unit, is for use in panelboards, switchboards, load centers and individual enclosures. For 480-v applications, the new breaker saves mounting space requirements by 40 per cent over the F frame, and is the same physical size as the E frame breaker. Coordinated thermal-magnetic operating characteristics are designed to assure protection against overload and short circuit conditions. Common tripping, quick make-quick break operation and a three-position operating handle are features. The EH frame breakers are available in two- and three-pole construction, 10 to 100 amp continuous ampere rating, 480 v a-c, 250 v d-c, and an interrupting rating of 10,000 amp. I-T-E Circuit Breaker Co.



90° butt-welding elbow—Crane offers 16 different butt-welding fittings—½" to 24" for all pipe strengths.

Socket-welding tee—The Crane line of socket-welding fittings includes 9 different types for sizes ⅛" to 4"; 2000, 3000, 4000, 6000 lb. W. O. G.—non-shock—temps. 100° to 1000° F.

Crane butt-welding globe valve—The Crane butt- and socket-welding end valve lines include bolted bonnet, lip-seal, pressure-seal and union bonnet valves in a variety of globe, gate, angle and check designs.

Forged steel welding-neck flange—One of 3 standard types of forged steel flanges available from Crane for welded piping.

Send for this NEW Crane Circular of Welding Fittings, Flanges, Valves

A concise four-page guide to Crane's complete stocks of welding fittings, flanges and valves is available for your reference use. It provides you with a fast, accurate method of ordering *all* of your welding piping materials *from one source of supply.*

Ordering everything from Crane is your assurance that your jobs will be installed with top-quality materials throughout. Crane branch warehouses in 140 cities and Crane wholesalers throughout the country are ready to serve your requirements for welded piping materials.

Make sure that you get your copy of the new Crane Welded Piping Materials Circular quickly. Fill in and mail the coupon today. If you want an extra copy for your welding shop, check the coupon as indicated.

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For more data circle 544 on Post Card

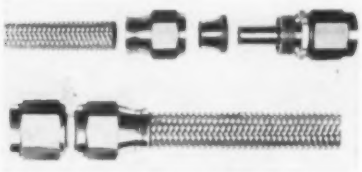
9—OPERATIONS RECORDER puts working data on tape

For use at electrical power generating stations as well as at unattended substations, the Millisecond Operations Recorder (called the MOR System) automatically records equipment operations sequentially on a printed digital tape. The resultant log sheet is useful in evaluating normal operations and in analysis of upset conditions. Time differences of 10 milliseconds between events are readily distinguishable. The system operates from regular station trouble contacts. In many cases contacts presently used to operate existing annunciators can be simultaneously used to operate the MOR System in parallel. According to manufacturer, these contacts need not be limited to those on protective devices but can be any contact which reflects "on" and "off" states. Standard 3-in. recording tape is printed with date and time of event, number of trouble contact involved and direction of change.

Individual relay devices per point are not required, it is pointed out, and channel equipment employed are passive devices involving no mechanical motion. The unit is transistorized, and the design claimed to assure long operation as well as inherent low cost — reportedly less than ¼ that of methods currently in use. The standard system is designed to handle any number of inputs up to 400 points. Fischer & Porter Co.

10—REUSABLE FITTING for high temperature Teflon hose

Seal-Lock is announced as an ideal field attachable-fitting for use with high temperature Teflon hose, in particular with company's Fluoroflex-T Hose. By means



of a triple locking feature, these fittings are locked to the hose and the components are locked to each other. They cannot loosen from vibration, it is claimed, and the lock can be inspected before completing the assembly. Fitting blow-offs cannot occur, manufacturer states. Two seals designed into Seal-Lock Fittings are dynamically actuated by internal pressure and are, therefore, positive, it is pointed out; there can be no leaks. Left hand assembly threads serve to prevent accidental loosening during installation, and the flared skirt on the socket facilitates assembly yet protects the hose from concentrated stresses. Seal-Lock Fittings can be assembled in the field without special tools or special skills. Straight and elbow couplings in sizes from −3 through −20 are available. Resistoflex Corp.

11—GLOBE VALVES are highly corrosion resistant

For handling a wide range of applications, particularly acids and alkalis, this PVC Y-pattern globe valve incorporates several advantages. The disc facing is made of a slightly plasticized polyvinyl chloride said to retain corrosion-resistant properties, pressure-temperature ratings and other characteristics of the pure polyvinyl chloride valve body, while providing a resiliency that meets many valve seating requirements. Seating surfaces are not subject to galling, it is stated, and are less likely to be damaged if closed on hard foreign particles. The material is also reported to provide tight shut-off with minimum handwheel torque, even when slight irregularities are encountered. The disc is held on the stem with a U-type retainer to permit free rotation, and the large diameter stem end projects deeply into the disc to give accurate guiding of disc to seat. The valve comes in sizes from ½ through 3 in., in screwed or socket weld ends. Service rating is 125 psi, 145 F. Bulletin 290 gives more complete data. Manning, Maxwell & Moore, Inc.

12—WIRE STRIPPER handles insulated wire from 14 to 24 gage

Only 5 in. long, No. 299 Wire Stripper features a thumb-operated gage and is reported to strip all commonly used insulated wire from 14 to 24 gage without nicking or cutting. Even the larger sizes

of wire can be handled easily, says manufacturer. An advantage cited for the tool is that all settings can be made quickly with it. You simply turn the star gage to the desired notch opening size, notch and strip. Plastic grips lessen fatigue and the streamlined design permits work in tight places. Proto Tool Co.

13—PRESSURE TRANSMITTER is offered in seven ranges

The Compu-Tran Pressure Transmitter is announced as a low cost pressure to resistance transducer, designed especially for use in supervising and controlling pressure at remote locations. Many applications for this instrument can be found in steam- and hydro-electric plants where remote pressure information is telemetered or carried by direct line to central control stations. Its use cuts the cost of monitoring pressure variables in half, says manufacturer, and it permits such points as lubricating oil, feedwater pressures etc. to be placed under supervisory control with minimum installation expense, using existing instrumentation. The instrument is declared accurate to ½ per cent and comes in seven ranges from 15 to 600 psig. Bulletins R-1 and R-2 give data. International Resistance Co.

14—SPEED REDUCERS are helical gear units

Moduline is the name given a new line of helical-gear, speed reducing apparatus. Basic subassemblies and accessories are combined to make any helical gear drive configuration, and the use of parts common to a variety of configurations has enabled mass production. Heart of the gear line is a double-reduction cage with a fixed 5-to-1 set of low speed gears. High-speed change gears are mounted on rolled spline shafts so that they can be mounted or replaced with common hand tools. Gears in the triple and quadruple reduction subassemblies are also spline mounted. Seven unit sizes to 30 hp are available with ratios of 5-to-1 to 625-to-1.

Stock components are the building blocks for the gear motors, separate speed reducers, and package motor (sugar-scoop) reducers. These standard components can be assembled into arrangements providing for floor, ceiling, wall or angle mounting. Addition of accessories provides further versatility. It is stated that by using the same basic parts, a hollow shaft and an aluminum cover, shaft-mounted reducers with any of the standard American Gear Manufacturers Ass'n ratings can be assembled. Westinghouse Electric Corp.

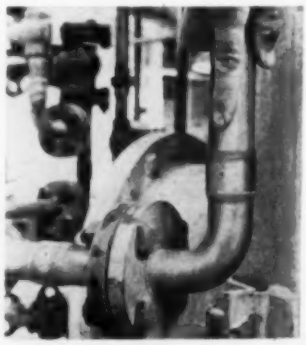
15—CONTROL SYSTEM for fans, pumps in heat exchange

The Varitrol Control System is designed to provide controlled variable speed for fans and pumps in heat exchange processes. This pneumatic system consists of company's Varidrive equipped with an automatic control, a temperature sensing transmitter, and a control panel. According to manufacturer, the system is completely automatic and will hold desired product output temperature within 1 per cent of desired value. It may be used in conjunction with heat exchange systems at pressures to 1000 psi.

The temperature transmitter is for installation at locations convenient to the process site. This transmitter supplies required input signal for the control panel. A gas filled bulb in the transmitter senses the desired temperature and generates a proportional pneumatic signal to the control on the Varidrive — thus the latter slows down or speeds up, depending on required correction, altering the speed of the driven fan or pump. Bulletin F-1882 gives data. U. S. Electrical Motors Inc.

16—ALIGNING CONNECTOR for stainless pipe welding

Stainless steel piping can be welded quickly by using this aligning connector, it is announced. The connector fits over ends of connecting sections permitting



in-place pre-assembly of pipe and fittings, and helps to align the system. Another advantage cited is elimination of icicles inside connections which impede fluid flow and cause turbulence in the line. Connectors are for use with light-wall stainless steel pipe, schedules 5 and

Why Mead-Morrison Coal and Ore Buckets move more material

Mead-Morrison buckets are constructed almost exclusively of lightweight, high-tensile alloy steel that provides maximum payload per pound of bucket weight, less load on the structure, lower power consumption and high resistance to abuse.

They are designed for greater ease of penetration and digging power.

Low maintenance results from design and proper use of high strength material in the bucket. Its riveted—not welded—construction maintains proper shell contour and correct alignment and facilitates field repairs.

A new patented, *non-jamming* jaw linkage is available that obsoletes all other hinge types in the handling of non-crushable material.

The next time you are considering replacing a bucket remember that *the bucket moves the material.* Cheap, heavy buckets down-rate your entire system. The higher capacity per pound of bucket weight and the strength of Mead-Morrison buckets guarantee that your overall system is operating at maximum efficiency.

For detailed literature on Mead-Morrison buckets write to: . . .

Mead-Morrison

division of

McKiernan-Terry Corporation

Harrison, New Jersey

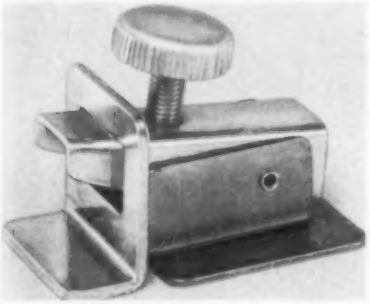
MK824

For more data circle 545 on Post Card

10 and Speedline fittings. They also connect with conventional schedule 40 systems. Since lightwall piping systems eliminate threading at joints, excess pipe wall is not needed to provide thickness required for screwed joints. Speedline Div., Horace T. Potts Co.

17—AIR-TIGHT FASTENER for doors sealed against gaskets

The No. 25 is a compression-type fastener for use where doors must be sealed against a gasket. Originally designed for use on company's dust collectors, the fastener is suggested for use in any air-tight, light-proof or vibration-resistant



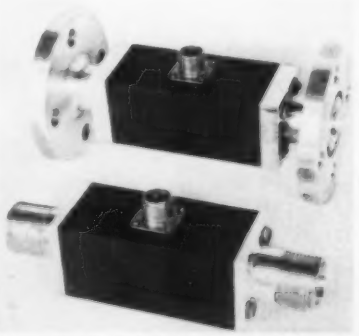
application. The fastening is cadmium plated and consists of a sliding, pivoted latch which is tightened down under the compression action of a thumb screw. The fasteners will cost as low as 30 cents per unit, depending on quantity. A sample fastener is available to qualified power engineers. Torit Mfg. Co.

18—RELAY TEST SET for underground network system use

These test sets have been developed for on-location or shop testing of underground network system protectors and relays. One box encloses the relay test set and one the mechanism test set. Either box, weighing less than 10 lb, can be taken into manholes for checking the operation of the various components of the protector, such as the contactor, breaker closing and tripping, current transformers and master and phasing relays. Multi-Amp Corp.

19—CONDUCTIVITY CELL mounts on main process line

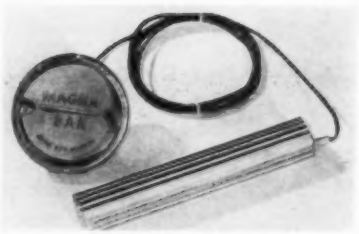
This in-line conductivity cell operates at temperatures to 400 F with temperature compensation and up to 1000 F when not using temperature compensation without need of sampling lines and coolers. The new conductivity cell consists of a hollow glass cylinder containing two electrodes and an automatic temperature compensator. The electrodes and thermistor for temperature compensation are embedded into the glass cylinder, which is in a metal housing. Connections are made using a four-prong Amphenol connector, thereby enabling the cell to be used with a variety of controlling, recording and indicating instruments. The automatic temperature compensator is designed to function up to 400 F. Without automatic compensation temperatures may be as high as 1000 F. Both flanged or threaded ends are available. It is noted that because the platinum electrodes are mounted flush with



the surface of the glass tube, high fluid velocities can be maintained through the cell. Shifts in calibration due to a changing cell constant is thereby minimized. Four available pipe sizes range from ¾ to 1 in. Instrument Div., Robertshaw-Fulton Controls Co.

20—ALLOY BAR protects fuel storage tanks, oil burners

Magna-Bar was designed to eliminate varnish and sludge in heating oils, and to reduce corrosion of fuel storage tanks. The device is a bar of alkaline alloy metal about 4 in. long. It can be quickly installed in an oil storage tank, and is suspended from a wire attached to tank cap. The cap, wire and Magna-Bar come as a unit and two types are available for indoor and outdoor or underground tanks. It achieves its effect by means of a chemical reaction in which varnish and sludge-forming catalysts and corrosive acids formed in tank are



neutralized. It is explained that corrosion that does occur attacks the alkaline alloy bar rather than the tank itself. Johns Mfg. Co.

21—COMPACT A-C MOTOR for synchronous applications

The Syncro-Spede is announced as the first synchronous induction motor built in the same NEMA frame size as a standard motor of equal horsepower. According to manufacturer, the Syncro-Spede accelerates as an induction motor but runs at exact synchronous speed without permanent magnets or d-c excitation involving collector rings and brushes etc. It is claimed the most compact a-c motor available for synchronous uses and to offer high power factor and efficiency. It is suitable for many applications requiring constant speed with varying load, company says, and because of its size, it can provide precise frequency systems in small generator ratings. And since this motor is unaffected by voltage fluctuations, it is suggested for precision timing and metering devices and for recording instruments. Offered in ratings from 1 to 100 hp in any enclosure type, it can be foot- or flange-mounted, and is designed for horizontal or vertical mounting. Bulletin 1900 gives detailed information on the Syncro-Spede motors. Louis Allis Co.

Reader Service Cards on pages 127–128 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

22—DRAFTING MACHINE can be carried in pocket

Draftette is so compact it can be folded jacknife-style to fit in the pocket when detached from its drawing board. It is available attached to a portable drawing board that fits into a briefcase. The unit

takes the place of T-square, ruler, protractor and triangles. Draftette is of aluminum construction, black with white-filled numbers and letters of the scale and 180-deg protractor. Draftette can be had with three sizes of drawing boards. With the smallest board, 10 by 13 in. in size, the cost is around $6.00. David Miller & Associates.

23—HEAVY DUTY V-BELT for long center industrial drives

Condor LS (length stabilized) Belt features a proportioned construction reported to eliminate V-belt whip and similar causes of turnover and eventual failure. Its redesigned belt compression area and repositioned strength members are claimed to give the belt a degree of lateral and longitudinal stability not formerly possible with long center drives. Tests are reported to show the belt is exceptionally smooth-running over extended periods of continuous service without undue stretch or wobble even where large drives require the belt to travel the reverse bends of idler pulleys at high speeds. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

24—INSULATING COMPOUND cushions irregular shapes

Volseal is an electrical sealing compound in tape form. It is described as an easily-handled, high dielectric insulating material used primarily to seal and build up cable splices. Volseal is claimed to conform to irregular shapes and act as an excellent padding insulator to round out sharp corners around terminals, connections, bus bars and motor lead junctions. The tape comes in rolls 1½ in. wide, 5 ft long, ⅛ in. thick. This ribbon-form, putty-like substance needs only to be wrapped and shaped into place, to fill

Filters

Basic filter parts include: the outside container, the bed of filter medium and the distribution and collection systems to provide a uniform flow through all parts of the bed. Flow rates average 2 to 3 gallons per minute per sq. ft. of bed area.

Filter beds are cleaned periodically by reversing the flow and increasing it to about 10 to 20 gpm per sq. ft. (backwashing). This lifts and swirls the sand, loosening the dirt and flushing it to waste.

Rotary surface washers with high-velocity water jets may be used to help break up the layer of dirt on top of the bed.

After backwashing, the first water through the filter (rinse water) also picks up some dirt and is run to waste.

A "multiport valve" replaces 5 individual valves and reduces the number of valve manipulations for cleaning a filter from 10 to 3. It also indicates the cycle in progress and ensures proper sequence. Operation can be made completely automatic with hydraulically- or motor-operated valves controlled by meters, timers and float switches.

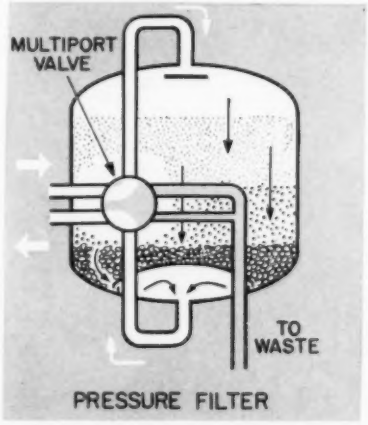
SAND FILTERS for removing dirt, precipitates, suspended solids

Sand filters simply "strain" the water as it flows downward through the filter bed. It is probably the oldest and most widely used method of water treatment.

Gravity filters. Practically all large public water-supply plants include a series of gravity filters made of concrete for permanence and low maintenance cost. Sizes run up to 400 or 500 sq. ft. for each filter.

Chief difference among concrete gravity filters is the method of water collection under the filter bed. The false bottom system provides uniform collection but requires about 2 ft. extra filter height and is highest in cost. Header-lateral collection systems of steel pipe are lowest in cost but do not provide perfectly uniform collection and can corrode. There are also patented systems such as Permutit's *Monocrete*® system which uses collapsible forms for casting lateral ducts in the concrete itself. *Monocrete* ducts are oversize for uniform collection and are corrosion-free since no metal is used. The cost is less than for false-bottom construction.

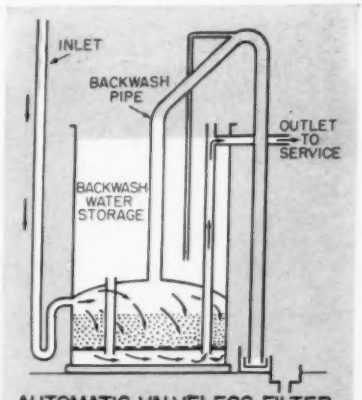
Steel-tank gravity filters cost less than concrete in small and medium sizes and are generally used in industrial plants. Wood-tank filters have low maintenance cost, but they are not practical for large sizes and not as attractive as painted metal. They are now used primarily where there is a metal shortage.



PRESSURE FILTER

Pressure filters deliver an effluent under pressure, usually under 100 psi, to eliminate repumping. Since no water depth is required over the bed to provide pressure, these filters are smaller and lower in cost than gravity filters of the same capacity.

Vertical pressure filters are available to 12 ft. diam. with approx. 113 sq. ft. of bed area. Horizontal pressure filters provide large filter-bed areas, up to 200 sq. ft., at lowest tank cost but may not maintain as uniform bed conditions as vertical type.



AUTOMATIC VALVELESS FILTER

Automatic Valveless Filters (gravity type) are a new Permutit development. They greatly reduce filter cost because they use no valves or flow controllers. They provide completely automatic, foolproof self-operation yet actually cost less than conventional manually-operated gravity filters. Sizes up to 12' diam. available.

When the suspended matter removed by the filter bed causes the pressure loss to reach a predetermined figure, backwashing starts automatically. At end of backwash, flow reverses automatically, and the backwash storage compartment is then filled with a brief rinse plus filtered water. Filtered water then passes to service through a separate outlet.

FILTER MEDIA for removing oil, bad tastes, odors, etc.

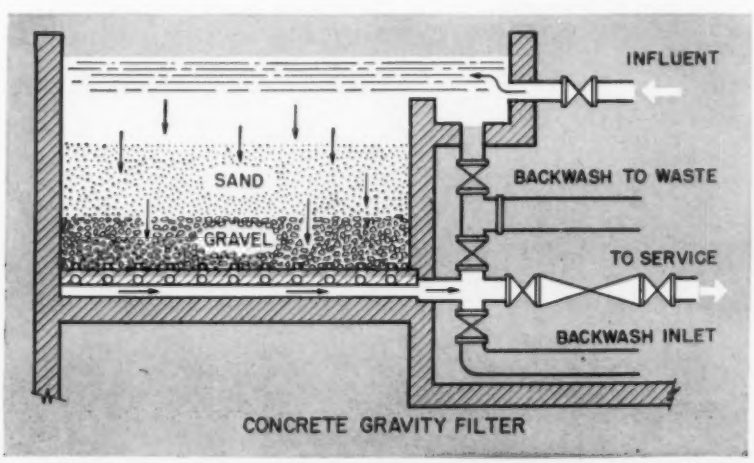
Graded anthracite coal. Used in place of sand to minimize pick-up of silica following hot-process softening of boiler feedwater or for removal of oil from steam condensate.

Activated Carbon (Carbo-Dur®). Absorbs excess chlorine and dissolved elements caused by decayed vegetation or algae that affect taste and odor. Carbon filters or "purifiers" are backwashed to remove suspended matter picked up by the filter.

Calcium Carbonate (Neutralite) raises the pH of low-pH, corrosive water at the same time that it filters.

Manganese zeolite oxidizes and removes moderate amounts of iron and manganese, also hydrogen sulphide, chief cause of "rotten egg" odor and sulphur taste. It is regenerated with potassium permanganate.

For information on filters or other water-conditioning equipment, write: The Permutit Company, Dept. PE-2, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.



CONCRETE GRAVITY FILTER

PERMUTIT®
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Water Conditioning
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Improved Operation

of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

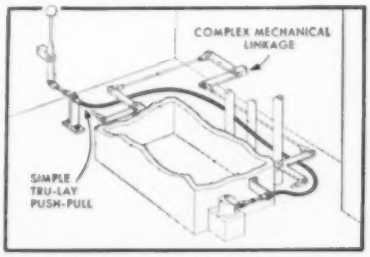
Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts.

Advantages of Tru-Lay Push-Pull flexibility and simplicity are pictured below

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when the conduit is COMPLETELY IMMERSED in water.

Lubrication of the inner member and conduit are for life.

Temperatures as low as −70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

*Our **DATA FILE** will answer your further questions*
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AMERICAN CHAIN & CABLE

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and seal hollows or contour. Once applied, it forms a smooth working surface ready for overwrapping with electrical tape. According to manufacturer, Volseal has an average dielectric strength of 445 v per mil of thickness and is capable of continuous performance at 160 F. Company says it is permanently plastic and won't dry out or harden excessively, in addition to being resistant to acids and alkalies. Dutch Brand Div., Johns-Manvil'e Corp.

25—HAND TOOL crimps solderless terminals AWG 8 to 4/0

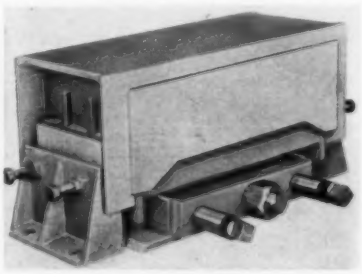
The Rota-Crimp, a multi-range hand tool, is for use in crimping company's solderless electrical terminals and connectors through the entire AWG range

of 8 to 4/0. Multi-faced crimping dies are permanently mounted within the head of this tool. You select the proper die, to match the size terminal being installed, by loosening locator pins and rotating dies to the desired position. American Pamcor, Inc.

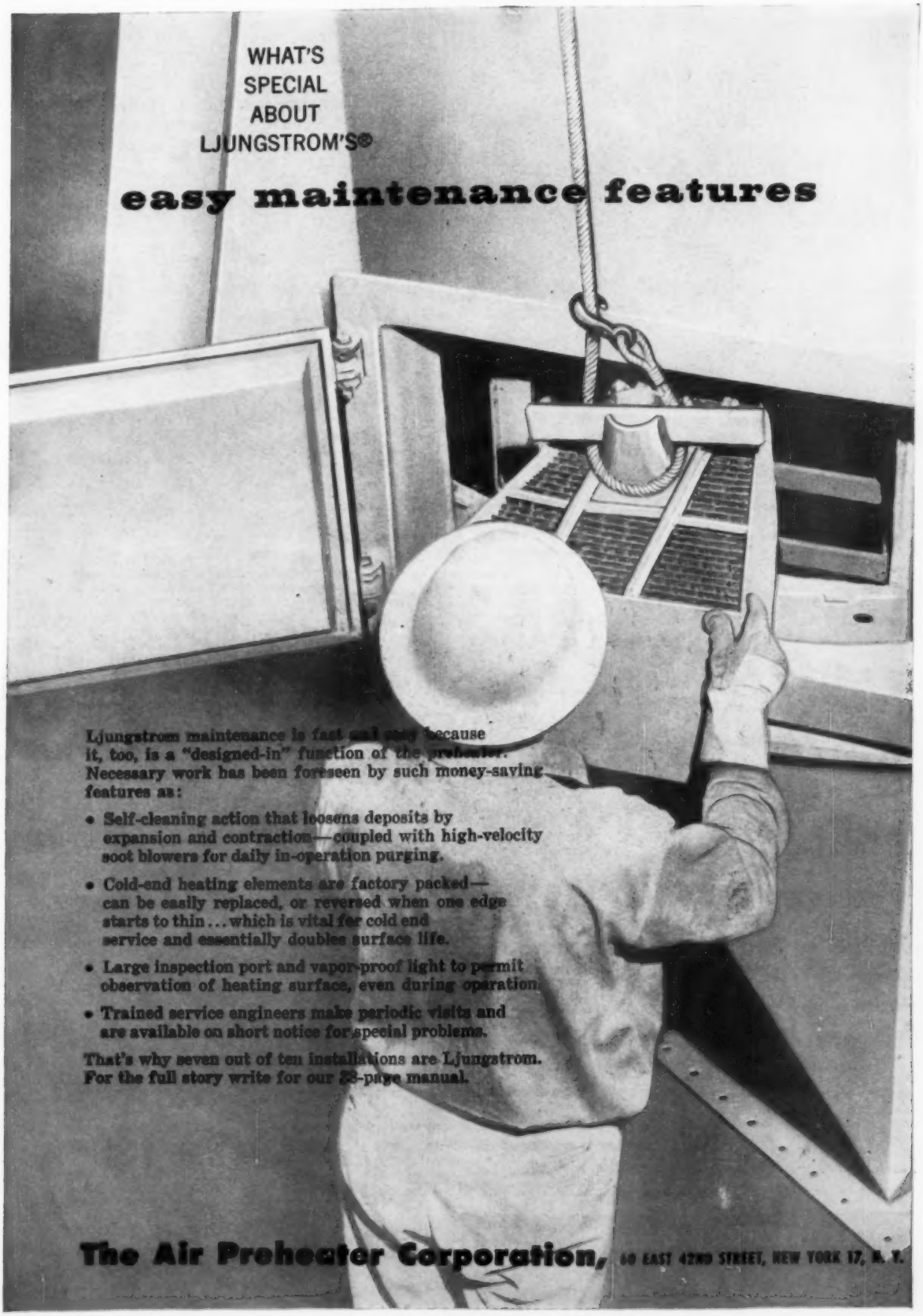
26—MACHINE MOUNTS simplify heavy equipment installation

Type SW Mountings are reported to simplify installations of the heaviest equipment, reduce installation time, frequently eliminate special chassis or foundation, and increase machine life. The Type SW is described as a vibration, shock and noise isolator utilizing steel springs as the isolation medium; it is available in seven load-carrying capacities from 38,000 to 125,000 lb each. Lengths range from 20 to 35 in.; widths, from 12 to 20 in.

For use with heavy, bulky machinery, the unit is claimed unique in that it is adjusted and leveled from the side, rather than by means of a bolt protrud-



ing from the top. Its flat top permits placing the unit in any position under a machine base to provide maximum support of the base, company points out, regardless of availability, location or size of foundation bolts holes. In many cases, it eliminates the problem of drilling holes in bases, it is noted, and shims are not needed. A feature of the Type SW is the internal device which facilitates leveling the machine installation with less torque than required by many leveling systems. This lower torque re-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ABOUT
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easy maintenance features
Ljungstrom maintenance is fast and easy because it, too, is a "designed-in" function of the preheater. Necessary work has been foreseen by such money-saving features as:
• Self-cleaning action that loosens deposits by expansion and contraction—coupled with high-velocity soot blowers for daily in-operation purging.
• Cold-end heating elements are factory packed—can be easily replaced, or reversed when one edge starts to thin... which is vital for cold end service and essentially doubles surface life.
• Large inspection port and vapor-proof light to permit observation of heating surface, even during operation.
• Trained service engineers make periodic visits and are available on short notice for special problems.
That's why seven out of ten installations are Ljungstrom. For the full story write for our 28-page manual.
The Air Preheater Corporation, 60 EAST 42ND STREET, NEW YORK 17, N. Y.
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for Powdered Coal, Granular Materials, Gases containing Solids

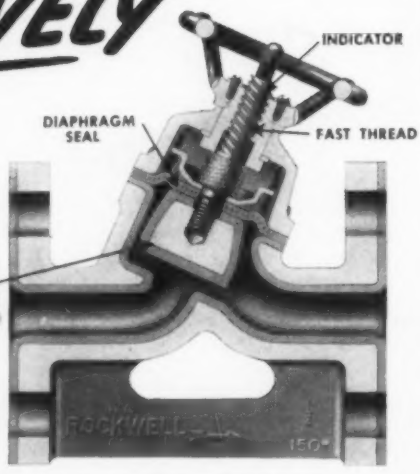
KWIKLEEN VALVES

Not only do these valves provide full pipe flow (unobstructed by seats or bends), as well as quick shut-off, but they minimize time loss in cleaning. Accumulated solids drop into sediment chamber. Bottom end plate is quickly removed and solids drop out. No dismantling from pipe line.

Kwikleen Valves are made of any required metal in standard 4" to 16" sizes and special larger sizes; manual or mechanical operators. Write for bulletin.

CLOSES and SEALS POSITIVELY

"D-D" Diaphragm Valve



Disc for Positive Closure
Diaphragm for Positive Sealing

Ideal for corrosive, hazardous or delicate liquids and slurries; water, air, gas; vacuum service.

- No packing gland to leak. Mechanism not exposed.
- Oversized ports; high capacity; low pressure drop. Largest capacity of any diaphragm type valve.
- Self-draining in horizontal position.
- Lower handwheel torque and fewer turns to close.
- Lower thrust for automatic operation.
- Body of any metal or with any lining.
- Sizes ½" to 6".

Write for Bulletin.

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quirement is said to be of particular value, since these mounts are used to "float" machines weighing up to 1,000,000 lb. The Korfund Co., Inc.

27—OHM-METER is battery or rectifier operated

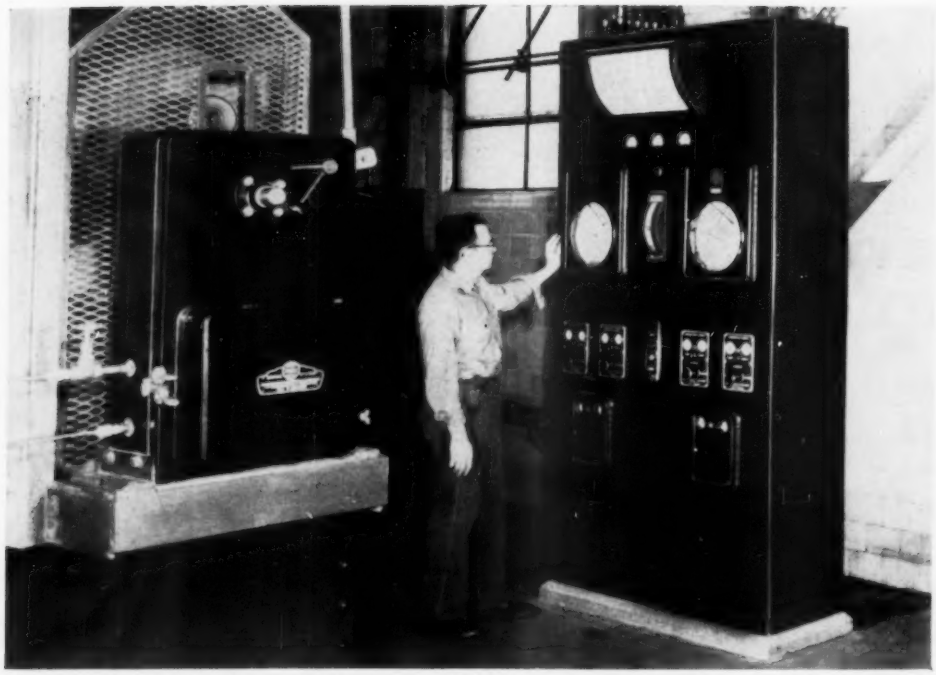
This new Megger Low Resistance Ohmmeter is a direct-reading instrument of compact design, weighing only 10 lb. It is designed to measure accurately down to 10 microhms, has a 3¼-in. scale and four ranges: in addition to the xl position on the selector switch, it multiplies scale x10, x100 and x1000. In electrical maintenance, this instrument's uses include resistance measurements of electrical conductors, joints, contacts and windings of the low resistance type in oil circuit breaker assemblies, rotating electrical equipment, transformer and coils. The instrument also lends itself to production testing. Two models are available, one having a battery power supply and the other a rectifier which may be plugged into a lighting circuit outlet. The instruments are provided with a quick-acting automatic circuit-breaker, in the current circuit, which is actuated by a trip coil when potential across the resistance being measured is excessive. Bulletin 24-46 gives complete details. James G. Biddle Co.

28—UTILITY PUMPS are fast-priming, all aluminum units

These self-priming aluminum pumps come in 1½- and 2-in. sizes powered by suitable recoil start engines. The pumps are designed to eliminate the need of a check valve, and a self-lubricating mechanical shaft seal is provided to eliminate leakage. They incorporate a defuser priming system to permit rapid priming with a minimum of water in the pump case. The cover plate is readily removable for pump inspection. Discharge outlet can be changed to any one of three positions. Base of the unit is so designed as to afford maximum flotation for the pump in soft or muddy ground. When used on a hard surface, rubber shock feet may be added. The smaller size utility pump weighs under 50 lb. Marlow Pumps Div., Bell & Gossett Co.

29—VALVE OPERATOR is explosion-proof unit

The SM-11-X Valvetrol is announced as an explosion-proof electric valve operator which mounts directly on the stem of rotary valves and provides proportional flow control for a-c or, d-c signal. It may provide remote control from a pushbutton station with meter indication of valve position, or it may provide proportional control in auto-



This Bailey Control System helps cut fuel costs on a 70,000 lb per hr capacity 125 psi boiler in an industrial plant. Control drive in foreground regulates stoker.

How Bailey stretches your fuel dollar...

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

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You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

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Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

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There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering control on your steam plant control problems.

A132-1

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Instruments and controls for power and process

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STRONGER and SAFER for every high pressure pipeline duty...

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Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

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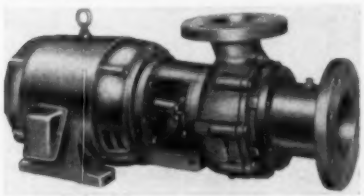
matic systems with the control signal originating from a d-c, zero to 5 milliamp source, or from an a-c control signal. A built-in potentiometer or differential transformer serves to provide positioning accuracies of ±½ of 1 per cent of full scale for standard models. Conversion from manual to remote or automatic operation is obtained for most valves by removing the handwheel and installing the Valvetrol. The Jordan Co., Inc.

30—END SUCTION PUMP for general service

Type BC Pumps are general purpose units in close-coupled horizontal, flange mounted vertical, base mounted vertical, and pedestal mounted horizontal models. Sizes range from ¼ to 40 hp at 3500 rpm, ¼ to 20 hp at 1750 rpm. Suggested uses for the pumps include circulating, coolant, cooling towers, con-



densate return, filters, others. According to manufacturer, these pumps possess low NPSH characteristics to meet critical suction conditions. The pumps may be changed from packing to seals by means of interchangeable inserts; mechanical seal, and water-cooled stuffing box with mechanical seal, and water cooled packing box. Details are in Bulletin 119-C. Aurora Pump Div., The New York Air Brake Co.

31—GEAR MOTORS, shaft mounted, right angle type

This line of shaft mounted right angle gear motors includes sizes from ¼ to 5 hp. The shaft mounted design offers simplicity and efficiency of installation, it is noted, because it eliminates intermediate transmission elements. Coupled with the weight saving characteristics of aluminum construction, these right-angle gear motors are designed to provide a compact installation especially suitable for lighter pieces of machinery or use in small areas. The smooth surface can be easily cleaned, company notes, making the unit ideal for chemical and food industry applications. Sterling Electric Motors, Inc.

32—GATE VALVES, of aluminum alloy, for problem fluids

Ranging in size from ½ to 24 in., these aluminum alloy gate valves are said to include types for all requirements where aluminum piping systems are used or planned. The valves incorporate company's principle of fully revolving double disc parallel seat gate valve operation. According to manufacturer, worthwhile savings are possible, particularly in large valves, compared with those of other metals suitable for handling problem gases and fluids. Such savings are said to accrue not only in the shipping, handling and installation of the lighter weight aluminum valves, but also in their initial cost due to basic weight and material cost factors in manufacture. Darling Valve & Mfg. Co.

Don't Let High Fuel Costs Burn Up Profits

AIRETOOL

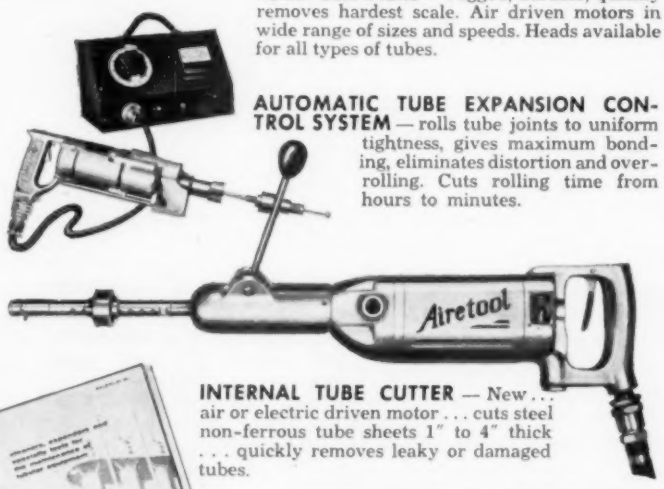
TUBE MAINTENANCE EQUIPMENT GETS RID OF POWER-ROBBING SCALE-CLOGGED AND LEAKY TUBES

In minutes . . . not hours . . . AIRETOOL TUBE CLEANERS will clean out power-consuming profit-robbing scale-clogged tubes.

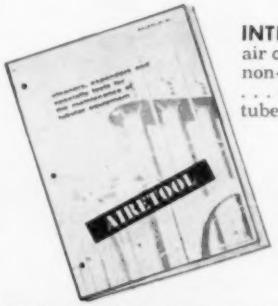
Faster than ever before, AIRETOOL CUTTERS remove faulty tubes . . . In less than half the time you would expect, AIRETOOL'S TUBE EXPANSION SYSTEM automatically rolls new tube ends to accurate, tight, leakproof joints. There's no doubt about it . . . you need AIRETOOL Equipment for your tube maintenance program!

CONDENSER CLEANERS — fast, powerful, easy to operate. Muffled motor, built-in flushing system cools drill, removes cuttings.

TUBE CLEANERS — rugged, durable, quickly removes hardest scale. Air driven motors in wide range of sizes and speeds. Heads available for all types of tubes.



AUTOMATIC TUBE EXPANSION CONTROL SYSTEM — rolls tube joints to uniform tightness, gives maximum bonding, eliminates distortion and over-rolling. Cuts rolling time from hours to minutes.



INTERNAL TUBE CUTTER — New . . . air or electric driven motor . . . cuts steel non-ferrous tube sheets 1" to 4" thick . . . quickly removes leaky or damaged tubes.

Write for Airetool Bulletin No. 60. Illustrated . . . shows complete line of Airetool tube maintenance and construction equipment plus Airetool specialty tools.

AIRETOOL

MANUFACTURING COMPANY

316 S. Center St.

SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

REPRESENTATIVES: in principal cities of U. S., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii

EUROPEAN PLANT: Vlaardingen, The Netherlands

CANADIAN PLANT: Brantford, Ontario

For more data circle 552 on Post Card

High Strength Bolting

continued from page 90

the erection crew used three pneumatic wrenches for installation and one mechanical torque wrench for inspection. Impact wrenches were set slightly above the minimum recommended tightening torque (470 ft-lb for $\frac{7}{8}$-inch bolts, the size used in most joints on this job). Impact wrenches were checked twice daily with a calibrator that checks bolt tension.

All bolts were inspected for marks that would indicate they had been engaged by the torque wrench. The mechanical torque wrench was used on approximately 3 per cent of the fasteners to check torque that had been applied by the pneumatic wrenches. Only two bolts were found to be under-tightened in inspection. These were simply retightened. Close control of torque wrench calibration reduced other inspection requirements. In riveting, a fastener believed to be improperly driven must be cut out and replaced; a time-consuming, tedious job which often loosens adjacent rivets.

The ease with which joints are set up for bolting also helped reduce Houston Lighting's costs. Pinning or drifting was reduced to a minimum since it was not required at any hole in which a bolt could be entered. The use of bolts minimized use of floats and scaffolds.

Several additional units for Houston Lighting & Power Co's rapidly growing system are in erection or blueprint stages now, and it is planned to erect them with high tensile bolts.

Ebasco anticipates that the practice of high tensile bolting will continue the rapid growth it has enjoyed since it was introduced as a major construction innovation about five years ago. THE END

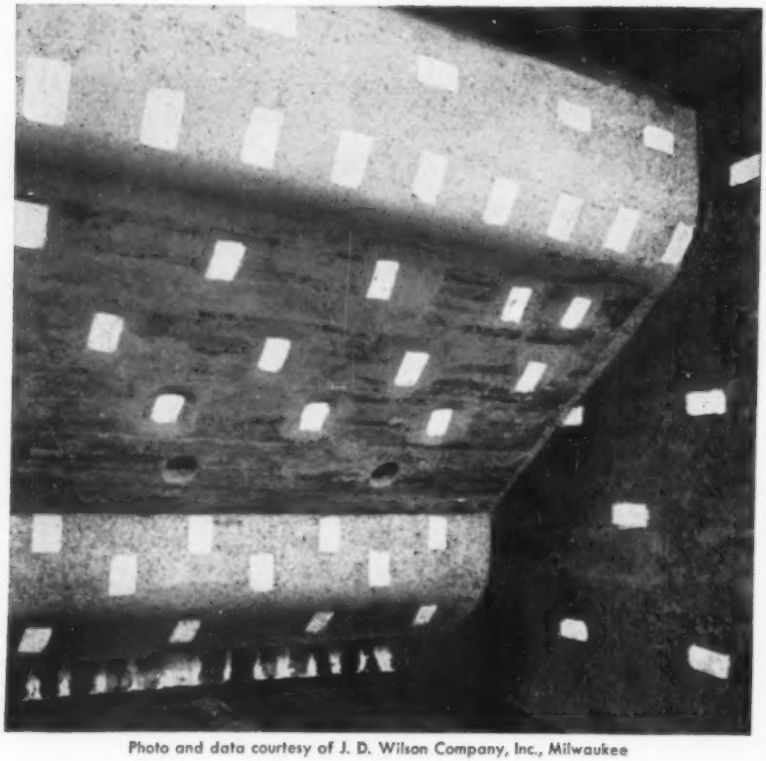


Photo and data courtesy of J. D. Wilson Company, Inc., Milwaukee

Laclede Super Plastic Refractory Helps Cudahy save $250,000

Here's how Cudahy Brothers Company saved the cost of a new boiler. Engineers rejuvenated an old 607 hp., 4 drum boiler by opening its bottled-up furnace and designing a new arch. The new furnace walls and arch —of Laclede Super Plastic Fire Brick—increased furnace volume by over one-third.

Output soared from 37,000 lbs. of steam to 50,000 lbs. hourly. The old boiler now operates at 150% to 175% of rated capacity, and works continuously except for short cleaning periods. Formerly, low efficiency and high refractory maintenance limited operation to six weeks a year. Now it competes with Cudahy's newest steam generator. Maintenance was zero for the first three years and has been negligible since then.

This potent combination of good engineering and Laclede refractories gives older boiler settings new life. It sends new ones off to a flying start. For more information, write *Laclede-Christy Works, Refractories Division, H. K. Porter Company, Inc., St. Louis 10, Mo. In Canada, H. K. Porter Company (Canada) Ltd., Guelph, Ontario.*

H. K. PORTER COMPANY, INC.
REFRACTORIES DIVISION

For more data circle 553 on Post Card

"Boss, I'm phoning from subdivision Z of station L—where am I and how do I get back?"

Unretouched photo showing typical return line corrosive action resulting from carbonic acid and dissolved oxygen in condensate.

BREAKING DOWN WITHIN

This section of pipe looks like new—on the outside. But take a look inside. Grooving action caused by carbonic acid and deep pitting, the result of dissolved oxygen attack, have almost completely penetrated the pipe wall.

Dearborn FILMEEN* prevents such destruction. FILMEEN forms a protective, non-wettable barrier between treated steam, or condensate, and metal pipe surfaces. By preventing the carbonic acid and dissolved oxygen from coming into contact with the metal, FILMEEN assures corrosion-free lines. FILMEEN is only one of many Dearborn water conditioning products scientifically developed to control specific corrosion problems. Others eliminate scale, sludge, carry-over and similar difficulties.

Power engineers in leading industrial and commercial plants place their confidence in Dearborn's 70 years of experience in water chemistry. They have found the answer to the demand for complete plant protection in Dearborn Supervisory Service—a properly balanced water conditioning program which combines quality products with correct, technically supervised control methods and test procedures.

Let a Dearborn Engineer survey your plant and recommend the type of water control program best suited to your requirements.

**FILMEEN is the trade-mark of a corrosion-inhibiting compound patented and produced exclusively by Dearborn Chemical Company. U.S. Pat. No. RE 23614.*

Dearborn®

...a leader in water conditioning and corrosion control for 70 years

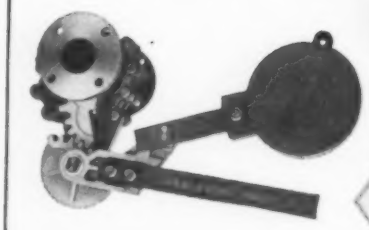
Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PG-F, Chicago 54, Ill.

Gentlemen: ☐ Have a Dearborn Water Conditioning Engineer call.
☐ Send me complete information on Dearborn Water Conditioning Program.

Name.....*Title*.....
Company.....
Address.....
City.....*Zone*.....*State*.....

For more data circle 554 on Post Card

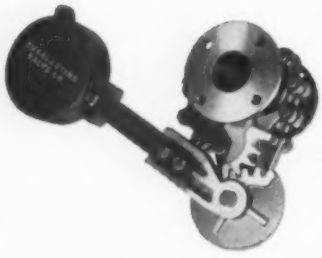
For Everlasting Protection in Emergencies



OPENING TYPE

to divert water to sprinkler deluge or water curtain systems, or to divert inflammable liquids to a point of safety.

Write for Bulletin E52C



CLOSING TYPE

to shut off the flow of inflammable liquids or to concentrate water or steam in fire mains.

Both types can be controlled thermostatically, electrically, or manually from any or many locations. Their design assures positive, dependable protection because they do not wedge and consequently cannot stick.

EVERLASTING Valves

EVERLASTING VALVE CO.
47 FISK STREET, JERSEY CITY 5, N. J.

EV301

For more data circle 555 on Post Card

Death of James W. Parker

JAMES W. PARKER, a man whose exceptionally warm personality was a strong influence in the development of the nation's electric power industry for nearly 50 years, died December 30, 1957. He was known personally by many hundreds of utility people throughout the United States and abroad. He had continued both his public service and professional engineering activities throughout the six years since his retirement as president of The Detroit Edison Co.

He died suddenly of heart failure in the midst of work aimed at leading young engineers and the engineering profession toward new and

James W. Parker

broader horizons. He was himself an engineer, not just of the turbines and towers of electric power systems, but of youth and hope and enterprise, and better things for more people.

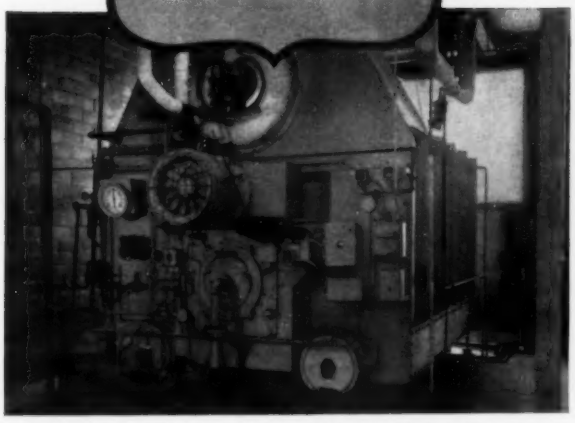
James Parker came to Detroit Edison in 1910 as a 23-year-old Cornell University graduate. He went to work in overalls at the company's old Delray Power Plant as the first young technical man with a sheepskin to serve a boiler-room apprenticeship under the direct supervision and close scrutiny of an operating crew. His success in his down-to-earth duties did much to establish Detroit Edison's — and other companies' — policy of starting out youthful engineers in the most basic jobs of the organization.

As the years passed, new assignments brought wider experience and ever-increasing responsibility. In time, James Parker became Chief Engineer of Power Plants, then Vice-President and Chief Engineer, then General Manager, and finally President and General Manager of his company.

He directed the design and engineering of Detroit Edison's first generating units at Conners Creek Power Plant; the building of the Marysville and Trenton Channel plants and Delray Power House Number Three; and the rebuilding

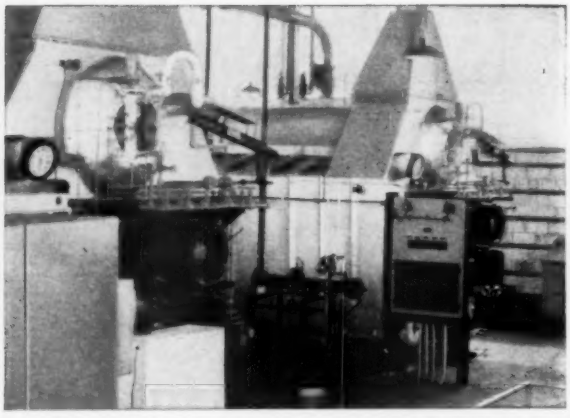
four more economy-minded users capitalize on

UNION PACKAGED BOILERS



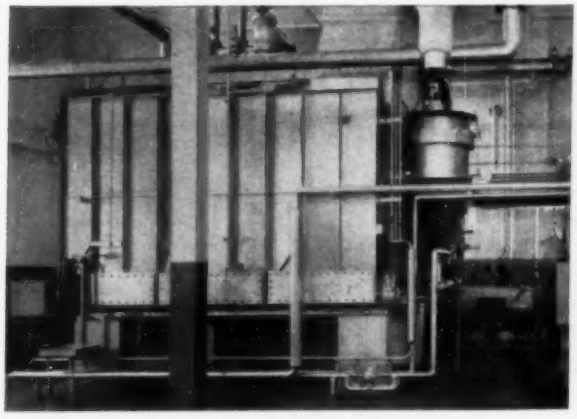
"NEEDED FLEXIBILITY" FOR EXPERIMENTAL CANNERY

The Green Giant Co., reputedly the world's largest packer of peas and corn, selected an 8,500 lb./hr. Union Packaged Boiler on the basis of "proven past performance of this type of unit." Installed to provide steam for its experimental processing plant, the MH Type Steam Generator provides "needed flexibility" to meet changing load demands of various process research projects.



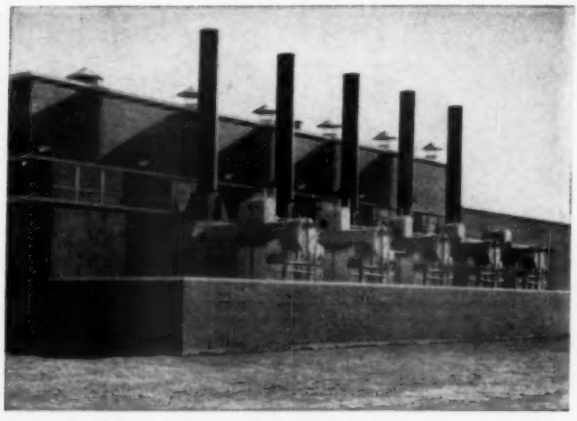
THRIFTY PERFORMANCE LEADS TO CHOICE OF SECOND MH

Following a policy of adopting "mechanical advances in machine design and automatic controls" to reduce costs, Mansfield Rubber Ltd. chose a 6,500 lb./hr. MH Boiler for its Ontario tire plant. "The performance and economy of this unit made the selection of a second quite simple," reports Mansfield. "We are particularly pleased with both boilers, especially when heavy steam is called for. They modulate well."



PICKED FOR SIMPLE, EASY INSTALLATION

Upon arrival, a new Union Packaged Boiler need only be positioned, connected up and lit off. In 1955, such simple installation was a big factor in the selection of this 20,000 lb./hr. unit for the new Hinde & Dauch plant at Eaton, Ohio. Delivering steam for space heat and processing, it plays an essential part in the manufacture of corrugated board for shipping boxes. This year, another MH (20,000 lb./hr.) was installed in H & D's Meriden, Conn. plant.



TWA BASE GETS STEAM THE MH WAY

Selected jointly by TWA management, city contractors and city engineers, this "MH" quintette serves the enormous overhaul base at Mid-Continent Airport, Kansas City, Mo. Individually rated at 33,000 lbs./hr., Union's five-boiler team provides space heat for the cavernous hangar and other buildings, plus a power generating source for various cleaning, plating and pumping operations.

FOR USEFUL DATA on Union Type MH Steam Generators (Capacities: 10,000-60,000 lbs./hr.) request illustrated Bulletin MH-353.

UNION IRON WORKS
ERIE, PENNSYLVANIA

For more data circle 556 on Post Card

BIDDLE *Instrument News*

Meg® Type
of Megger
INSULATION TESTER

With NEW A-R-K Switch Gives You ALL THESE FEATURES IN ONE INSTRUMENT

- Megohm Scale ÷ 1 and ÷ 10 (Formerly the A switch)
- Ohm Scale (Formerly the R switch)
- Capacitance Discharge (Formerly the K switch)
- Earth, Line and Guard terminals—no need to change terminal connections when switching to ohm scale

This multi-purpose switch affords you all these features in one instrument. Available with voltages of 500 or 1000 volts d-c and with ranges from 0 to 20 up to 0 to 2000 megohms—0 to 10,000 ohms.

For prices and specifications write for **BULLETIN 21-45-PF**

Biddle Motor and Phase Rotation Tester (*Dual Purpose*)

With it you can . . .

- **Determine the direction of rotation of electric motors before they are connected to the line.**
- **Determine the phase rotation or sequence of energized power circuits.**

Here is a positive means for determining which motor leads must be connected to certain conductors of a supply system to insure that the motor will rotate in a prescribed direction when energized.

This device will permit the electrical contractor or industrial maintenance electrician to permanently connect and tape the terminals of the motor being installed, without having to first energize the motor by a temporary "hook-up" from a power source, if available, to determine its rotation.

Housed in a sturdy oak case 12¼" x 8¼" x 4¼" this compact unit weighs approximately 10 pounds and is supplied complete with 3 line and 3 motor leads which store in the compartments either side of the instrument panel.

For complete details write for **BULLETIN 80-PE**

B-713R

JAMES G. BIDDLE CO.

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

1316 ARCH STREET
PHILADELPHIA 7, PA.

For more data circle 557 on Post Card

Death of James W. Parker

continued from page 114

of the Conners Creek plant in the middle and late 1930's. He contributed authoritative technical articles to *Power Plant Engineering*, now POWER ENGINEERING, and to other technical magazines. And his practical cooperation with technical editors was outstanding.

His warmth and understanding as a chief executive were reflected in the relations of his company with people — with customers, and with employes and labor unions. And he found time, despite his crowded days, for public service in both local and national affairs, as well as the affairs of his industry. In 1947 he was appointed chairman of the first Industrial Advisory Group of the U. S. Atomic Energy Commission. This was the beginning of peaceful industrial atomic energy development. In 1949 he went to Germany by request of the Military Governor, General Lucius Clay. There he studied the German utility systems and recommended dissolution of cartels and regulation by commissions patterned after those in the United States.

His retirement in 1951 was only a transition. He continued to serve his company as a director and his industry as an acknowledged leader. And in all the days of his busy life, until the end of his 71 years, he was the stout defender and protector of the best and most enlightened of American industrial principles and ethics.

NEW ENGINEERING BOOKS

Electrical Testing and Troubleshooting, by Philip T. Green, Industrial Training Coördinator, Panama Canal Zone Co. The Industrial Press, New York 13, N. Y. 1956, 200 pages, $4.00.

This book presents, in convenient step-by-step form, procedures for electrical testing and troubleshooting that have been used in the field by men responsible for installation and maintenance of electrical equipment. It covers a variety of methods of testing and correcting faults in circuits of all kinds including controllers, motors, transformers and transmission lines. The book will be a useful guide for practicing electricians and a basic text for those in training.

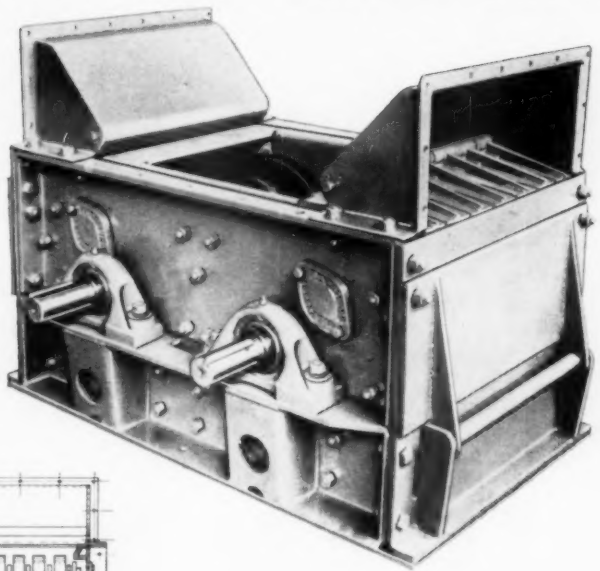
After a simplified briefing on how to understand electrical symbols and drawings, subjects treated include: Analyzing and charting controller operation, troubleshooting test equipment, insulation testing, locating grounds, electromagnet windings, d-c machine windings, simple phase transform-

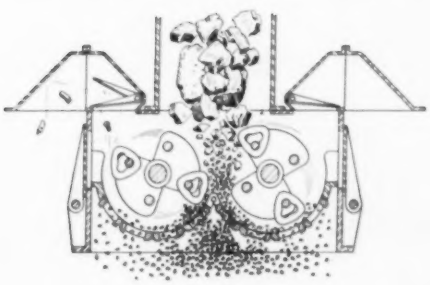
Reduce Coal to size in One Operation!

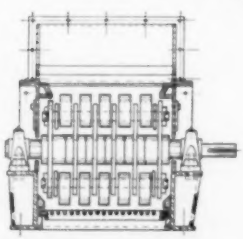
S-A RING TYPE KNITTEL CRUSHERS

HANDLE MAXIMUM SIZE LUMPS OF 14" TO 30"

CRUSH DAMP COAL IN SUSPENSION WITHOUT PLUGGING OR DECREASE IN CAPACITY!







S-A Knittel crusher is provided with tramp iron release fingers. Service and inspection doors are located at either end. Rotor shafts turn on Sealmaster Ball Bearings.

STEPHENS-ADAMSON

THE BIG NAME IN BULK MATERIAL HANDLING EQUIPMENT

MFG. CO.

MAIN OFFICE AND PLANT
86 RIDGEWAY AVENUE
AURORA · ILLINOIS

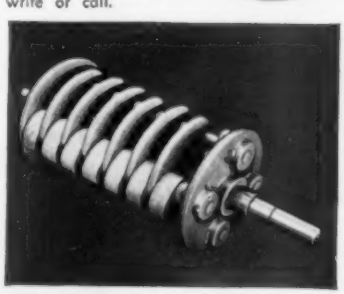
PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO

STEPHENS-ADAMSON crushers are built in several styles. A highly successful type, used in the sizing of coal, is the double rotor unit which splits lumps while they are in suspension, eliminating need of breaker plates. Full capacity is maintained. There is no clogging and even wet coal is reduced in a single, swift operation.

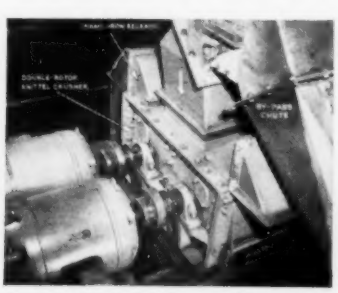
By using two rotors of smaller diameter, the double Knittel crusher will handle the same size lumps as larger single roll crushers which require greater headroom. Furthermore, no increase of power is required. Revolving rotor parts are free to recoil under impact with foreign material, thus preventing rotor injury.

A pioneer designer and manufacturer of conveying equipment for over half a century, STEPHENS-ADAMSON has created many of the world's finest coal handling systems. Whether you need a single conveyor product, or a fully engineered system, there's a member of the S-A sales engineer team in your area. He is eminently qualified to advise you. For complete catalog data on Knittel crushers, write for our bulletin 2-C.

S-A district or main plant offices can supply complete information on any conveyor product or any phase of coal handling. Just write or call.



Shown here is one of the two rotors from a double rotor Knittel crusher. The triangular sectors in each rotor assembly rotate toward each other at speeds up to 1150 R.P.M. Up to 1275 T.P.H. of bituminous coal can be handled in standard Knittel crusher sizes.



This double rotor type Knittel crusher installation sizes coal for an industrial power plant. Lumps are split and fragments are fed thru sizing grates beneath the twin rotors. Coal is then carried away by belt conveyor to outside storage or to boiler house bunkers.

For more data circle 558 on Post Card

PRESSURES:
2000 psi
TEMPERATURE
1200°F.

DON'T WORRY

THEY'RE PACKED WITH

JOHN CRANE

SEVERE SERVICE PACKING

Style 177AI

Here is the tough, dependable packing you've been looking for. Style 177AI is built to take punishment . . . to easily withstand pressures as high as 2000 psi . . . remain resilient at temperatures to 1200°F. It's a packing that will give you the kind of service you've always wanted in high temperature valves, soot blowers, gauge glass fittings and similar applications.

Style 177AI is dry graphite lubricated to reduce friction to a minimum. Each strand of the closely braided asbestos yarn top jacket is reinforced with Inconel wire. Core consists of long fibre asbestos and flake graphite.

Available in Spools or in Die-Formed Rings. Rings available with either square cross section or with special bevels for concave-convex nest sets.

Get full information on Style 177AI Packing now. Request catalog describing the full line of "John Crane" Packings.

CRANE PACKING CO., 6429 OAKTON STREET, MORTON GROVE, ILLINOIS (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

For more data circle 539 on Post Card

Engineering Books

continued from page 116

ers, phase sequence, polyphase transformers, induction motors, synchronous motors, power cable faults and bearing lubrication. Each subject includes adequate reference to applicable codes and standards.

★ ★ ★

Tentative Specifications for Copper and Copper-Alloy Welding Rods, 13 pages, 6 by 9 in., paper binding. Published jointly by the American Welding Society and American Society For Testing Materials; 33 West 39th St, New York, and 1916 Race St, Philadelphia, Penna., respectively. Price 40 cents.

This second edition specification covers copper and copper-alloy welding rods for use with the oxyacetylene carbon-arc, and inert-gas metal-arc, *non-consumable* electrode, welding processes only.

An appendix is included as an aid to users, in selecting the best rod for their needs, and for using it in the most efficient manner. It provides information on the use of each filler metal for joining different base metals with the different welding processes.

★ ★ ★

American Institute of Physics Handbook, coördinating editor, Dwight E. Gray. Size 6 by 9 in., buckram binding, in eight sections varying in length from 5 to 283 pages. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y. Price $15.00.

More than 90 specialists prepared the material for this important reference work. Over 100 subjects are covered in the eight sections of the book: mathematics, mechanics, heat, sound, electricity and magnetism, optics, atomic and molecular physics, and nuclear physics. Included is a wide range of tables, graphs, and summaries of formulas in all fields of physics. Much of the material is available otherwise only in scattered reference works and reports.

★ ★ ★

Handbook of Noise Control, edited by Cyril M. Harris. 1184 pages, 6 by 9 in., 700 illustrations. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y. Price $16.50.

This is announced as the first comprehensive handbook on the general subject of noise control to be published in the United States. Cyril M. Harris, its editor, is affiliated with Columbia University's Electronics Research Laboratories, and contributions from 45 other experts are included. Discussed in detail is the nature of noise, its measurement, and techniques of its control in buildings, industry, transportation, and the community.

Fundamentals, practical methods and engineering techniques, and useful reference data are given on such subjects as how noise affects man's efficiency, hearing, speech com-

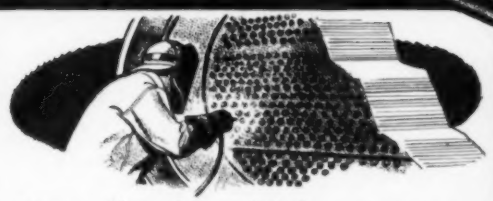
POWER POINTERS

IT'S CURTAINS

FOR FLUE-GAS CONTROL PROBLEMS

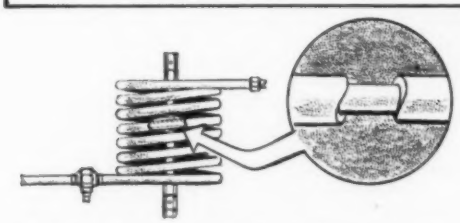
...0.005-INCH INCONEL ALLOY CURTAINS

FLUE GASES...UP TO 800°F...WERE TOO HOT FOR REGULAR ASBESTOS DAMPER CURTAINS IN ONE ELECTRIC COMPANY BOILER. SO THE CURTAIN MANUFACTURER DESIGNED ONE MADE OF METAL. IT HAS THE SAME WINDOW-SHADE ACTION; THE SAME FLEXIBILITY. BUT IT'S MADE OF 0.005-INCH THICK INCONEL* NICKEL-CHROMIUM ALLOY SHEET. THREE YEARS OF ASH-LADEN STACK GASES HAVEN'T CORRODED OR WORN THE INCONEL CURTAIN TO ANY NOTICEABLE DEGREE.



New all-welded high-pressure feedwater heater

THIS NEW, ALL-WELDED FEEDWATER HEATER ENCOUNTERS PRESSURES TO 3600 PSI...INLET STEAM TO 790°F. TO INSURE RELIABLE OPERATION, "140" MONEL* NICKEL-COPPER ELECTRODES WERE USED TO WELD ITS FOOT-THICK STEEL TUBE SHEETS TO COPPER-NICKEL TUBES. THE HIGH NICKEL CONTENT OF THIS ELECTRODE MAKES POSSIBLE DUCTILE, NON-POROUS WELDS THAT STAY STRONG UNDER SEVERE CONDITIONS.



NEW INNER TUBE FOR STEAM SAMPLER GIVES EXTRA "MILEAGE"

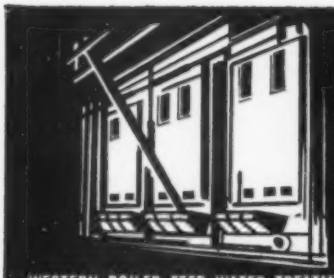
AT A MID-WESTERN POWER PLANT, STRESS-CORROSION CRACKING RUINED INNER TUBES OF HIGH-TEMPERATURE STEAM SAMPLER COILS IN SIX MONTHS OR LESS. A SWITCH TO INCONEL ALLOY HAS TRIPLED INNER TUBE "MILEAGE" EVEN THOUGH THE SAME THERMAL SHOCK AND CORROSIVE CONDITIONS EXIST.

WHAT'S YOUR METAL PROBLEM?

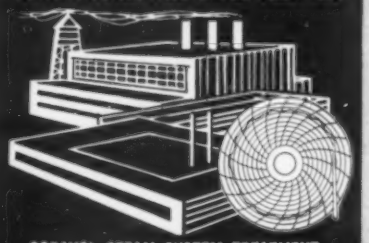
MAYBE AN INCO NICKEL ALLOY CAN REINFORCE YOUR INGENUITY AND LEAD TO A QUICK SOLUTION. TO EXPLORE THE POSSIBILITIES, WRITE FOR INCO BULLETINS COVERING THE ENGINEERING PROPERTIES OF INCONEL AND INCONEL 'X' ALLOYS AND MONEL AND 'K' MONEL ALLOYS.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.
INCO TRADE MARK **Nickel Alloys**
*Registered Trademark

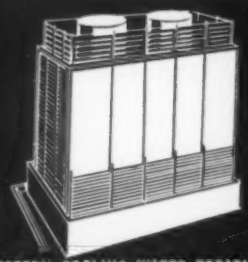
For more data circle 560 on Post Card



WESTERN BOILER FEED WATER TREATMENT



CORAVOL STEAM SYSTEM TREATMENT



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Engineering Books

continued from page 118

munication; vibration and its control; and use of various materials and methods in controlling industrial noise.

Treatment of special types of noise sources and their control includes such trouble spots as gears, bearings, fans, air distribution systems, water systems, transformers, motors, and refrigeration systems. Also covered are sources and control of aircraft, automobile, and rail transportation noise, community and legal aspects (including anti-noise ordinances) and compensation for industrial hearing losses.

Subject matter in each chapter is arranged so that the solutions to practical noise control problems, which do not require highly theoretical considerations, can be found without going into the more advanced technical considerations except as the reader may desire.

* * *

Rome Cable Manual of Technical Information. Second Edition, 393 pages. Published by Rome Cable Corp, Rome, N. Y., 1957. Price $4.50.

One hundred and thirty pages have been added to this wire and cable manual, first published 10 years ago. Manual is divided into eight sections: wire and cable technical tables, wire and power cable engineering calculations and data, communication frequency data and calculations, national electrical code data, properties of metals, general technical information, conversion tables, and cable installation practices. There is a 23-page alphabetical index.

The index has been greatly improved to simplify use. For example, under Current Carrying Capacities there are 48 listings covering this subject. They are conveniently broken down by voltage classifications, copper temperatures, load factors and cable types.

* * *

Welding Handbook, Fourth Edition. 560 pages, 6 by 9 in., cloth binding. Published by the American Welding Society, 33 West 39th Street, New York 18, N. Y. Price $9.00.

This fourth edition of an old standby is appearing in a new format. Instead of one volume to cover the wide scope of welding, the new Handbook will be printed in *five* sections. Also, the sections will be published at the rate of one a year; Section I is now in print.

This first section covers basic welding practices and fundamentals; its eleven chapters cover those phases common to all types of welding, such as terms, design of joints, cost estimating, and safe practices, among others.

Data collected from manufacturers, experts and practical men, plus information

SOLID WHEEL

spells non-stop turbine performance

It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.
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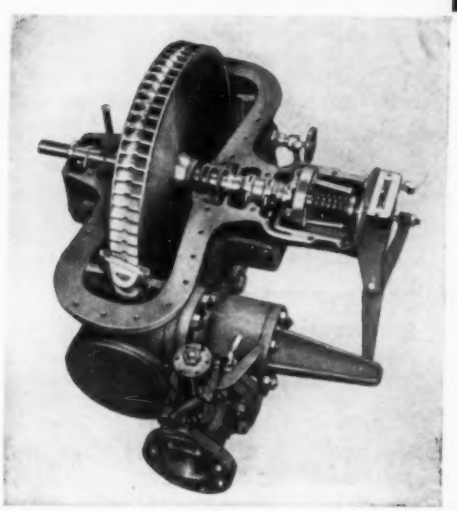

Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY

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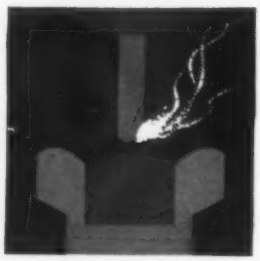
THE STEAM
IS HOTTER

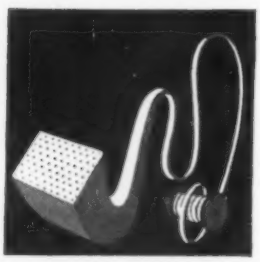
Modern boilers are producing steam at higher temperatures. Old-time valve stem packings just can't stand the gaff.

THE PRESSURE
IS HIGHER



Rugged construction is a must in modern valve stem packings. R/M has designed the ruggedest: braided asbestos, with Monel and Inconel wire reinforcement, over a high-temperature resistant plastic core.

R/M LICKS
YOUR PROBLEMS



Practically no organic materials to burn, lubricants ground in during manufacture – good at stuffing box temperatures to 1150°F.

7 BASIC TYPES
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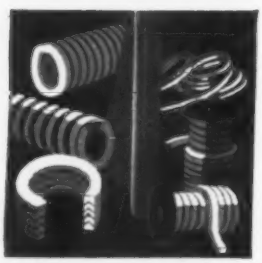
AND INVENTORY



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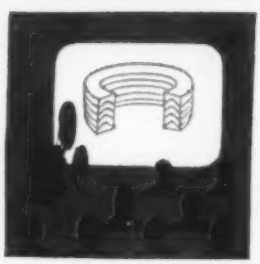

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Engineering Books

continued from page 120

taken from company files, have contributed to the completeness of this book. No single author could possibly do what the American Welding Society has done through its membership affiliations in the field. The Handbook is well conceived as a textbook, engineering treatise and practical operating manual.

★ ★ ★

Underground Systems Reference Book. 624 pages, 8½ by 11½ in., cloth binding. Published by the Edison Electric Institute, 420 Lexington Ave, New York 17, N. Y. $11.50 to member companies; $12.50 to non-members.

The original edition of this standard reference came out in 1931; now it has been revised to include all the developments of recent years.

This volume was prepared by 134 experts, and required 3 years to compile. Standards of 34 utility companies were studied in an effort to include all common practices. Many manufacturers, utilities, and technical experts contributed valuable information and data.

It is a well-written, nicely illustrated treatise on all practical and technical phases of underground electrical distribution methods, materials and techniques. In addition, all phases of the subject which are common to underground and overhead distribution are so indicated.

★ ★ ★

American Drafting Standards Manual. Four sections totaling 89 pages, 8½ by 11 in., paper binding. Published by the American Society of Mechanical Engineers, 29 W 39th St, New York 18, N. Y. Prices: Section 1-$1.00; Section 2-$1.50; Section 4-$1.50; Section 5-$2.00.

These drafting standards are now completed; these sections, together with others yet to be approved, will comprise the complete manual, but will be published separately by ASME.

The various sections are: 1, Size and Format, 2, Line Conventions, Sectioning and Lettering, 4, Pictorial Drawing, and 5, Dimensioning and notes.

★ ★ ★

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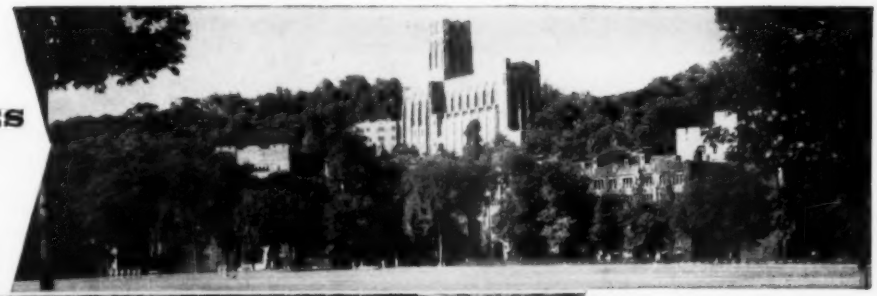

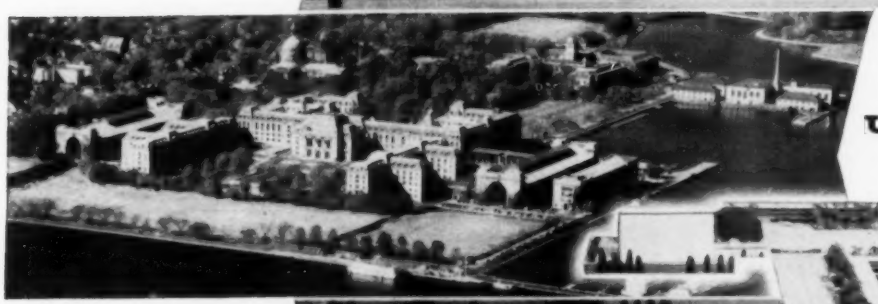

UNITED STATES NAVAL ACADEMY

UNITED STATES AIR FORCE ACADEMY

Photographs courtesy United States Military Academy, United States Naval Academy, and United States Air Force Academy.

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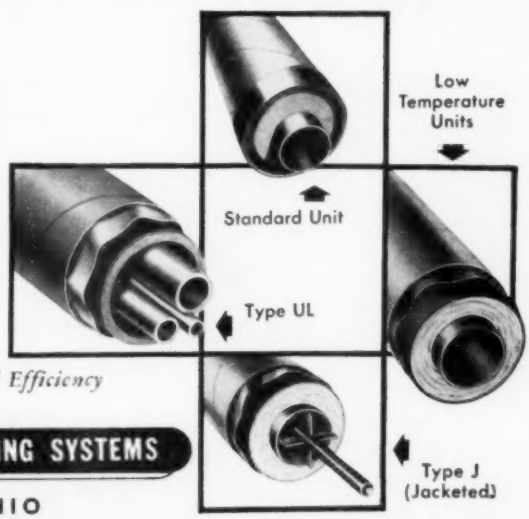
West Point and Annapolis have been serviced by Ric-wiL piping systems as far back as 1931. Since 1946 alone over 15,000 feet of Ric-wiL prefabricated piping has been purchased for the nation's top military colleges. Installation of Ric-wiL piping at the new 17,500 acre United States Air Force Academy has already been installed. Ric-wiL is indeed proud of the part they have played in serving these military academies for a period of over twenty-five years.



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CONSTRUCTION NEWS

Los Angeles, Calif. — Southern California Edison Co, 601 W Fifth St, has announced that the company has awarded a contract to Babcock & Wilcox Co for the construction of a new steam-electric generating unit for its new power plant at Huntington Beach, Calif. New unit will provide 1,638,000 lb of steam per hr to a steam turbine with a capacity of 200,000 kw, at a pressure of 2400 lb. per sq in. and a temperature of 1050 F.

San Bernardino, Calif. — California Electric Power Co, 3771 W 8th St, Riverside, Calif., has announced plans for contract award to the Fluor Corp for the design and construction of a 60,000-kw reheat turbine generator unit to be added to company's Coldwater Steam Plant, near here. This is the second unit of its type to be installed at this plant. Work is already under way and installation will be completed in 1959.

Chicago, Ill. — Commonwealth Edison Co, 72 W Adams St, has announced plans for the sale of bond issue to total $50,000,000, proceeds of which will be used for extensions and improvements in power plants and system, including transmission lines, power substations and other company operating facilities. Expansion costs for the four-year period through 1961, are projected to about $600,000,000. Utility's construction timetable calls for outlays of $170,000,000 in 1958; $135,000,000 in 1959; $145,000,000 in 1960; and $150,000,000 in 1961. Expenditures for 1957 for construction purposes totaled approximately $200,000,000.

Ford, Ky. — East Kentucky Rural Electric Coöperative Corp has plans under consideration for the construction of a fourth steam-electric generating unit at company's Winchester power plant. Preliminary clearing of construction site is already under way and work on the new project will get under way at once. Burns & McDonnell Engineering Co, consulting engineer. Total cost of installation when completed in 1960 reported to be in excess of $30,000,000.

Detroit, Mich. — Detroit Edison Co, 2000 Second Ave, has announced that the total capacity of company's electrical system passed the 3,000,000-kw mark with the installation of its new 260,000-kw unit which was recently placed in line at the River Rouge Station. This is the second of three planned installations, the last of which will be placed in line sometime in 1958 and will have an initial capacity of 320,000 kw.

Springfield, Mo. — City of Springfield, City Utilities Board, 301 E Central St, has arranged financing through bond issue for the installation of the third generating unit to municipal power plant. Unit to be installed will have an initial capacity of 22,000 kw and is reported to cost approximately $8,487,000, with auxiliary equipment. Burns & McDonnell Engineering Co, consulting engineer.

St. Louis, Mo. — Union Electric Company of Missouri, 315 N 12th Blvd, has announced the purchase of a $10,000,000 steam turbine unit from the Westinghouse Electric Corp of Pittsburgh, Penna. The new turbine will have an operating capability in excess of 335,000 kw and is scheduled to be placed in operation by April of 1961. Exact location for the new turbine, while not determined as yet, will be either at company's St. Louis Meramec plant where it will become a fourth section, or at a new plant location where it will become a number one unit.

Hallam, Neb. — Consumers Public Power District of Nebraska, 1452 25th Ave, has announced that they have reached agreement with the AEC for the construction of a sodium cooled graphite moderated reactor at company nuclear power plant here. Initial installation will have a generating capacity of 75,000 kw. North American Aviation, Inc, will be consulting engineer of the project. Cost reported to be in excess of $29,000,000 when completed by early 1959.

New York, N. Y. — Middle South Utilities, Inc, 2 Rector St, has announced that the SEC has approved company plan for the swapping of a gas distribution system and related facilities between two of the company's subsidiaries, Louisiana Power & Light Co and Louisiana Gas Service Co, both of New Orleans. Under the plan, Louisiana Power will sell its non-electric properties to Louisiana Gas in exchange for a $4,900,000 promissory note and an undetermined number of common shares. Louisiana Power will eventually sell the Louisiana Gas stock. Parent company has recently arranged a construction budget for subsidiaries, of $15,000,000, through sale of stock.

Syracuse, N. Y. — Niagara-Mohawk Power Corp, 300 Erie Blvd W, has announced that it has placed in operation at company's Huntley steam-electric station, near Buffalo, N. Y., the largest electric generator in the State of New York. Unit has a net generating capacity of 200,000 kw, enough to serve over 700,000 average customers. Installation represents an investment of more than $30,000,000, and is the first of four such installations, recently noted in these columns. Other projects include a new hydroelectric plant and a large switching station near Utica and two 230,000-v transmission lines.

Parr, S. C. — Carolinas Virginia Nuclear Power Associates has announced plans for the construction of a new nuclear power plant in this area. The facility, a prototype of other larger plants planned by the four companies making up the CVNPA, will be located on a 900-acre site recently acquired by the South Carolina Electric & Gas Co, adjacent to company's hydroelectric and steam generating plants already in this area. New plant estimated to cost approximately $17,000,000 will have a generating capacity of 17,000 kw. First of its kind in the South, plant is reported to be planned not as a major producer of electricity but as a test model for larger plants in the future.

Calallen, Tex. — Central Power & Light Co, 120 N Chaparal St, Corpus Christi, Tex., has plans under way on the expansion and improvement of Lon C. Hill Electric Power Plant here, including the installation of a new steam-electric generating unit. New unit will have an initial capacity of 175,000 kw and will cost approximately $12,000,000 when completed in 1959. Company also plans extensions and improvements in transmission lines, power substations and other operating facilities.

Roanoke, Va. — Thompson Products, Inc, 23555 Euclid Ave, Cleveland 17, Ohio, has awarded a contract to the Babcock & Wilcox Co for boiler and related generating equipment installation at research and development center now under construction near here. Total estimate of this work reported to be in excess of $10,000,000 will be supervised by McConathy Hoffman & Associates, Inc.

Cartoon by Gluteck

"If I'd only listened to mother and gone into the ministry!!!"

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN
CONDENSER AND HEAT EXCHANGER TUBE EDITION

Inlet end of first pass of heat exchanger blocked by trash.

Cleaning Methods that Insure Longer Tube Life and Greater Operating Efficiency

The high cost of foreign matter in condenser tubes is all too well known. Slime, marine organisms, silt, cinders and trash —all create the common costly problems of decelerated heat transfer and accelerated corrosion.

An effective tube-cleaning program is of prime importance in helping to keep operating costs at economical levels. As with all conditions of heat exchanger and condenser tube operation, cleaning methods vary in virtually each situation, depending, of course, on the nature of contamination.

In some applications rubber plugs are found to be effective. Brushes and scrapers, too, shot through the tubes by compressed air or water can clear lodged debris. Sometimes, these methods are not wholly satisfactory; the presence of stubborn debris may call for "rodding." Maintaining strainers and using rotating or stationary screens are preventive maintenance aids that pay dividends.

Scale Removal

The use of acids or strong alkaline solutions, which are inhibited to reduce corrosion of the tubes, can often dissolve or loosen scale or slime on the tube walls. Here, again specifics must be known before the correct cleaning solution can be formulated to effectively solve the problem. Very important is the alloy itself; full familiarity with its chemical make-up is essential so that the cleaning solution attacks only the scale and not the metal.

Slime Prevention

A properly set-up schedule of chlorination is highly effective against the formation of slime on tube walls. Water characteristics must be taken into account before the correct concentration of chlorine in the water can be arrived at. Over-chlorination can result in accelerated corrosion by rupturing the protective film on the tube surface. When the chlorination procedure is satisfactory, a red-brown or amber-colored film forms on the tube surface. Slime decomposition also can lead to the formation of ammonia, particularly during shutdown or stand-by, which may initiate stress corrosion-cracking of copper alloys with a high zinc content.

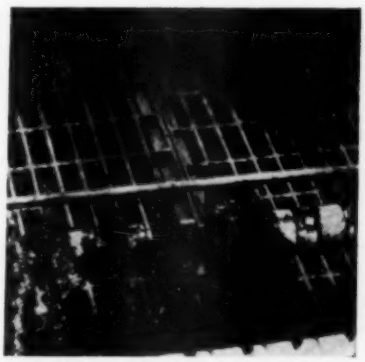
Biofouling

Biofouling organisms should be promptly removed from the tube surface by persistent scrubbing with a stiff brush and water. When these organisms die and dry on the tube surface it is doubly difficult to remove them, especially those with calcareous bases such as barnacles. When allowed to remain, the decomposition products of these organisms destroy the corrosion film and thus create a focal point for corrosion pitting. Increasing water velocity, when feasible, prevents the organisms from getting a fast hold, and is often helpful in reducing tube corrosion and maintaining heat transfer.

Biofouling in unchlorinated sea water.

Bridgeport Technical Service

You can always get help on your cleaning problems from Bridgeport Technical Service. Our familiarity with heat exchanger and condenser tube operation—under all conditions of contamination, both at sea and ashore—can help in analyzing your specific cleaning problem and result in a cleaning procedure that will help your tubes "live longer." For any information on the subject of tube hygiene, write or call the Bridgeport Sales Office nearest you.



Control of biofouling by chlorination of sea water.

BRASS Bridgeport CO.

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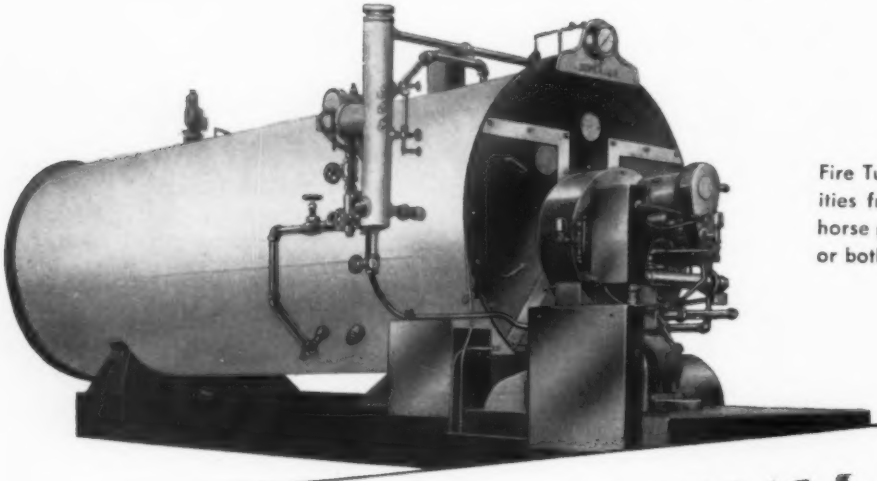

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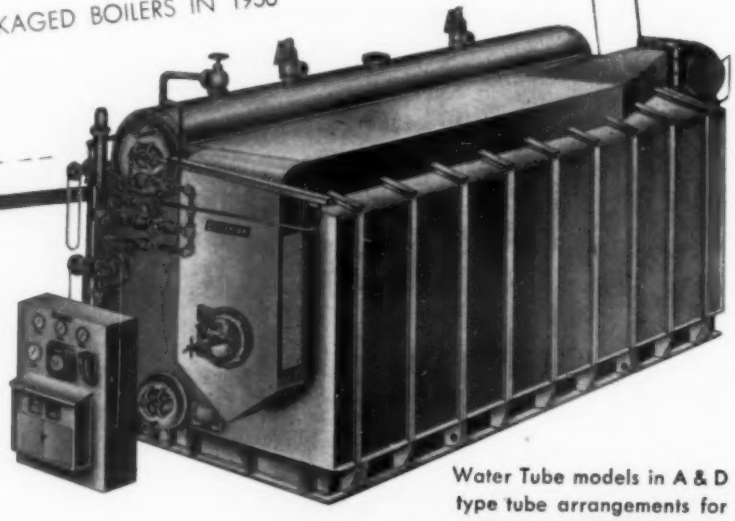
Water Tube Catalog 1006-W



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PUMPS, COMPRESSORS

201 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

202 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horisontal shaft, single-stage side suction pump; a horisontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

203 Non-Clog Pumps — Bulletin 121MV features Mono-Vane single passage impeller pumps designed for handling heavy settleable solids, long stringy solids, effluent etc. Both horisontal and vertical types are presented along with specifications. Mono-Vane impeller is described in detail, and various models of the pumps are pictured. Aurora Pump Div., The New York Air Brake Co.

204 Proportioning Pumps — Catalog 602, 8 pp, covers details and specifications of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are enumerated and capacities and pressures are tabulated on charts. Hills-McCanna Co.

205 Industrial Air Compressors — Twelve-pp Bulletin A-43 describes company's vertical design industrial air compressors supplying moderate amounts of air on a continuous 24-hr heavy-duty basis. Design features are described and illustrated by means of a cutaway view, and specifications and dimensions are tabulated. Joy Mfg. Co.

PACKINGS, SEALS

207 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross Braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at

FEBRUARY, 1958

NOTE: Card void after May 31, 1958

POWER ENGINEERING

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temperatures up to 800 C. Packings for every industrial application are covered and a recommendation chart is included. The Belmont Packing & Rubber Co.

208 **Packings and Gaskets** — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

209 **Mechanical Seals** — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

MECHANICAL POWER TRANSMISSION

210 **V-S Drive Selection Tips** — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

211 **Internally Geared Power** — Featuring latest design improvements in gearmotors and embodying 60 multicolor illustrntions, 16-pp Form F-1880 shows comparative advantages of gearmotors, lists ratings from ¼ to 30 hp with gear ratios as high as 10:1. Cross-sectional details and enlargements of outstanding features are included, as well as a discussion of use of elliptoidal helical gears, and a chart graphing degrees of tempering of gear teeth. U. S. Electrical Motors Inc.

212 **Fluid Drives** — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installations, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

213 **Flexible Cushion Coupling** — Bulletin A669, 12 pp, describes the Paraflex, a flexible cushion coupling, designed to automatically compensate for all combinations of misalignment and end float. Cutaway views and drawings are included, as well as coupling selection data and a table listing service factors for couplings. Dodge Mfg. Corp.

BOILERS, GENERATORS

214 **Water Tube Boilers** — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

215 **Automatic Boilers** — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining

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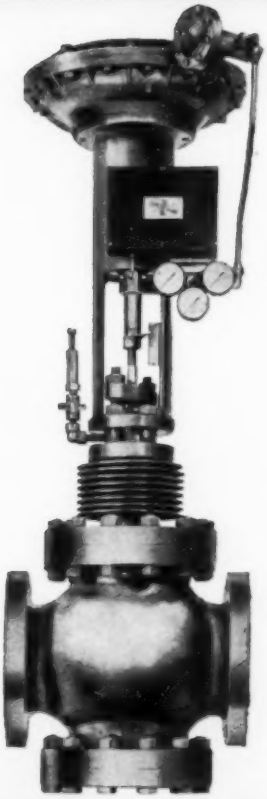
C-V NEWS NOTES



New regulator valve delivers on more jobs

Designed for remote control service, the Copes-Vulcan diaphragm actuated valve handles water, steam, air, gas, oil and other similar fluids with new efficiency. This valve has been engineered and precision-built for those operations requiring superior accuracy and sure dependability.

The Type-CV-D Valve may be direct or reverse acting. It has excellent rangeability and serves a broad variety of applications in sizes up to 12 inch.

Optional features include: cooling fins and stuffing-box lubricator to maintain low friction over longer packing life . . . auto-lock . . . top or side-mounted hand wheel for emergency operation.

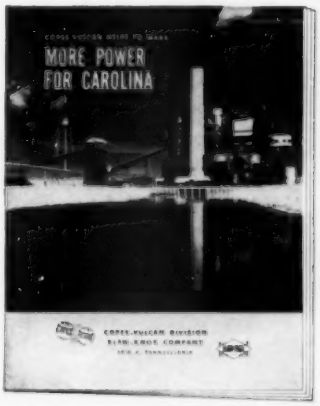
To assure trouble-free performance, Copes-Vulcan custom-designs each valve to suit your most exact control requirements. Write for Bulletin 1027.

Desuperheater developed to increase control

Based on a new steam-assist principle, this Copes-Vulcan Desuperheater permits close control of final steam temperature for processing work or auxiliaries. Using assisting steam only on lighter loads, it decreases the amount as the load increases. Exclusive swirl-chamber intimately mixes cooling water with steam. In-line type also available. Write for Bulletin 1024.

On-the-job report on boiler control

How Copes-Vulcan helps make more power for Carolina Power and Light Company is covered in this factual report on the Louis V. Sutton plant. Highlights include: Combustion, feed water, boiler feed pump re-circulation controls plus automatic-sequential soot blowing. Write for Bulletin 1032.



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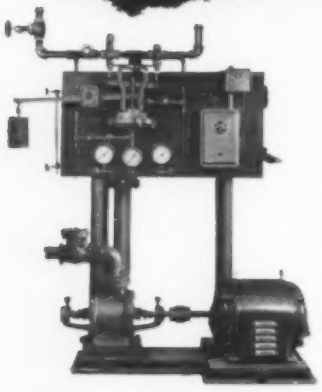
with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
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3. Reduces use of raw make-up water 85% to 90%.
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6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
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Steam Traps • Feed Water Heaters
Regulating and Reducing Valves
Drainage and Boiler Return Systems

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maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air. Boiler Engineering & Supply Co., Inc.

216 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2000 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

217 Hot Water Boilers — This 20-pp brochure describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications. Combustion Engineering, Inc.

218 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie-City Iron Works.

219 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data and dimensions for the units. Preferred Utilities Mfg. Corp.

220 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

221 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

WATER CONDITIONING

222 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

223 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

224 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and non-deaerating type are presented in 12-pp

THESE VALVES control

surge pressures silently

Center-guided type for lines from 1" to 10".

Globe-type for lines from 3" to 24".

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Write for Bulletins:
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No. 851 on Cause, Effect and Control of Water Hammer

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Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

225 Feed Water Deoxygenation — The advantages of chemical deoxygenation of boiler feed water with an aqueous solution of hydrazine are described in 12-pp Bulletin BW 5. How hydrazine serves to maintain boiler in cleanest possible condition, reducing iron oxide scale to a magnetic oxide, is fully detailed, and such considerations as economy and operation, handling precautions, storage are covered. Fairmount Chemical Co., Inc.

226 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

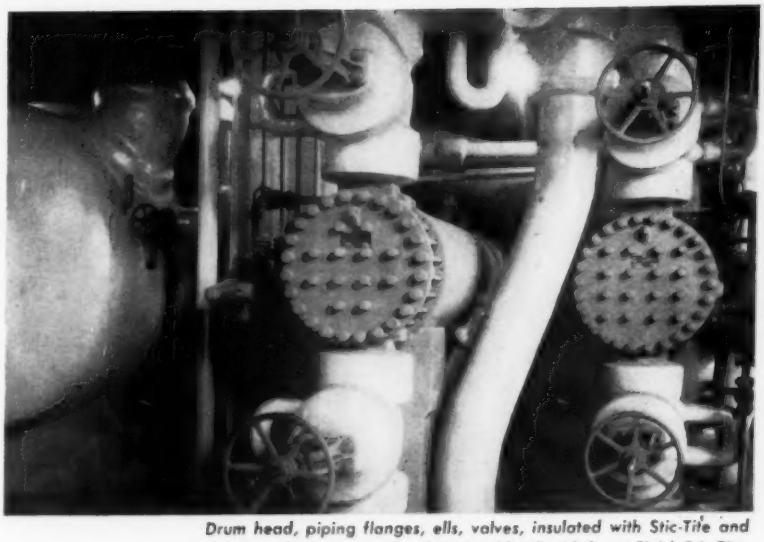
227 Valveless Filter — Operation of company's automatic valveless filter is described in this 8-pp illustrated bulletin. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

228 Data on Deaeration — This series of bulletins presents company's line of deaerating equipment for removal of dissolved gases from boiler feedwater etc. Publication 4651 describes Jet-Tray deaerators; No. 4652 covers tray-type units. No. 4653 deals with cold water deaerators used primarily to reduce or eliminate corrosion of piping systems, heat exchangers. No. 4654 describes a surface-type deaerating hot water heater for commercial and institutional use. No. 4643 covers self-contained Uni-Pac deaerators for small and medium size power plants. No. 4635, 12 pp, on atomizing deaerators, details deaeration by atomization and its applications. Cochrane Corp.

229 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

Do any of these catalogs answer your operating or maintenance needs? Let us know by circling the number of the catalog on the post card provided on pages 127–128. We'll do the rest!

230 On Demineralization — Technical Reprint T-140, 23-pp, a profusely illustrated article on demineralization, discusses advantages and disadvantages of this process for today's power plants. Developments, trends and applications of both multi-bed and mixed-bed ion ex-



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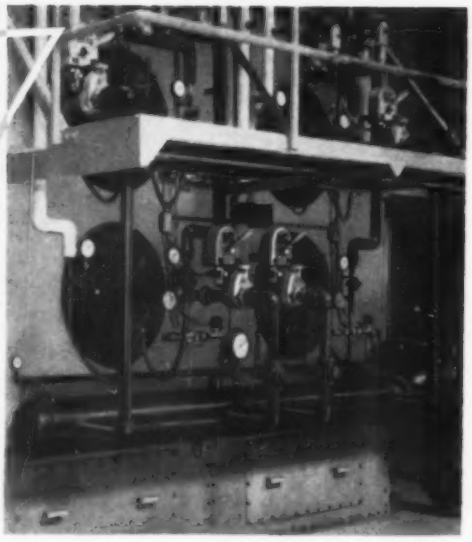

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ENCO Interchangeable Oil-Burners can be changed instantly to operate by either steam or mechanical pressure atomizing over a wide capacity range.

ENCO Oil Atomizers are applied to various types of standard pulverized-coal and gas-burner units cold starting or for full load operation when coal or gas is not available, or when oil is the more economical fuel.

Send for Bulletin OB-53 describing ENCO Gas and Oil Burners, also complete Pumping and Heating Units.

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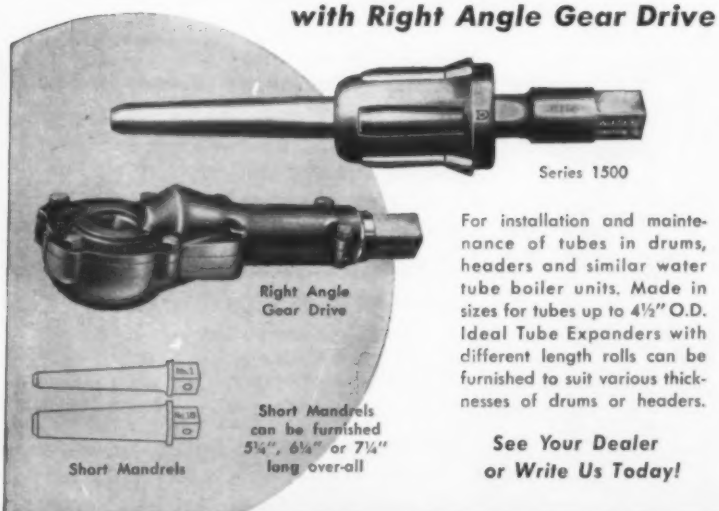
with Right Angle Gear Drive



For installation and maintenance of tubes in drums, headers and similar water tube boiler units. Made in sizes for tubes up to 4½" O.D. Ideal Tube Expanders with different length rolls can be furnished to suit various thicknesses of drums or headers.

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change are considered, and several case histories cited. A comprehensive bibliography lists 119 separate items. Tables, flow sheets, descriptive drawings, performance curves, process selection charts included. Graver Water Conditioning Co.

231 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization at flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

TUBING AND ACCESSORIES

232 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

233 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

234 Tube Expanders — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving sizes. Thomas C. Wilson, Inc.

235 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes, ordering tips and distributors. The Gustav Wiedeke Co.

FUEL BURNING EQUIPMENT

236 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

237 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

238 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 de-

scribes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

COAL AND ASH HANDLING

239 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features of the line and includes dimensions. American Pulverizer Co.

240 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

VALVES, TRAPS AND PIPING

242 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

243 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

244 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

245 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

246 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in nontechnical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

247 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer

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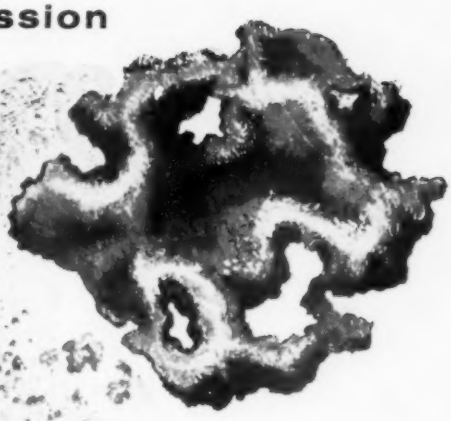
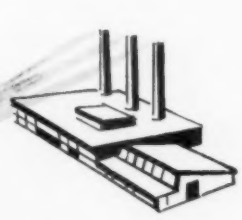


. . . to pollute the atmosphere and damage valuable equipment.

Flyash control is more important today than ever before in history because of the ever increasing number of industrial plants in operation. Each type dust has its own physical, chemical and electrical properties. To design dust collection equipment to capture these particles requires basic knowledge of the importance of these variables to the overall problem.

The Aerotec Corporation is experienced in the quantitative measurement of all dust properties and is equipped to carry out these tests before a recommendation for equipment is ever made. This ability, plus the most advanced design of both mechanical and electrostatic dust collectors, makes The Aerotec Corporation the logical choice to solve your dust collection problems.

Our Project Engineers, located in most principal cities in the United States and Canada, will be happy to supply you with information and literature on either mechanical, electrostatic or series dust collectors.



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45 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing. Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers, etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

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MOTOR-DRIVEN ROTARY OIL BURNERS
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butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

248 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

249 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. Photos, drawings and diagrams amplify the text. The Henry Pratt Co.

250 Valve Digest — Form 197R is a valve catalog digest furnishing the latest coverage of the OIC bronze, iron, cast steel, forged steel, and lubricated plug valve lines in a condensed form. Valves are classified by type and pressure class, and illustrated; this edition also includes face to face dimensions for each size and type of valve listed. The Ohio Injector Co.

251 Impulse Steam Trap — Bulletin T-1742, 8 pp, describes a line of impulse steam traps designed for a variety of trapping requirements. Contains information on operation, materials and capacities and includes dimensional and specification data, as well as photos of typical installations. Yarnall-Waring Co.

252 Trap Service Guide — To promote better trapping practice, pocket-size 32-pp Bulletin 7511 offers practical tips on installation, testing, and maintenance. Chapters are devoted to inspection and repair, trouble shooting, parts identification. Capacity charts are provided, also tables showing interchangeability of company's trap parts. Other sections deal with strainers, check valves, automatic trap drains. Armstrong Machine Works.

253 Insulated Piping—Bulletin 57-1, 24 pp, on prefabricated insulated piping systems, shows typical uses for Hel-cor pipe units for underground or overhead pipe systems. Also describes Utilidor conduits for protection of underground utility services. Sample specifications are given, along with conduit sizing charts. Ric-wiL, Inc.

254 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austenitic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

ELECTRICAL EQUIPMENT

255 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets,

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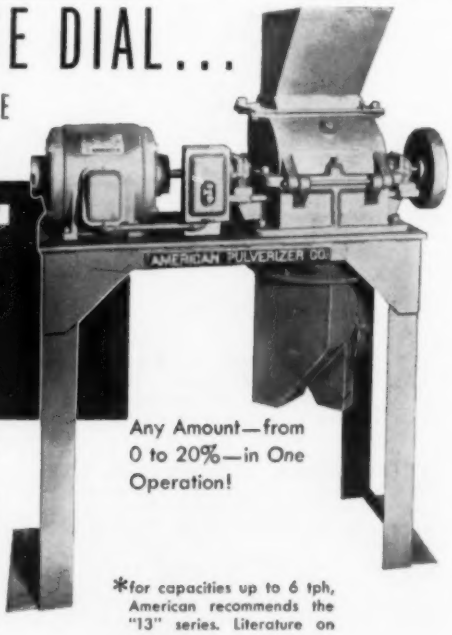

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motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

256 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

257 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. All information is condensed. Fully illustrated, book gives wiring diagrams, motor tables. Bussmann Mfg. Co.

258 Cable Troughs — This 12-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items, some typical installations and full list of distributors. The Globe Co.

INSTRUMENTS, CONTROLS

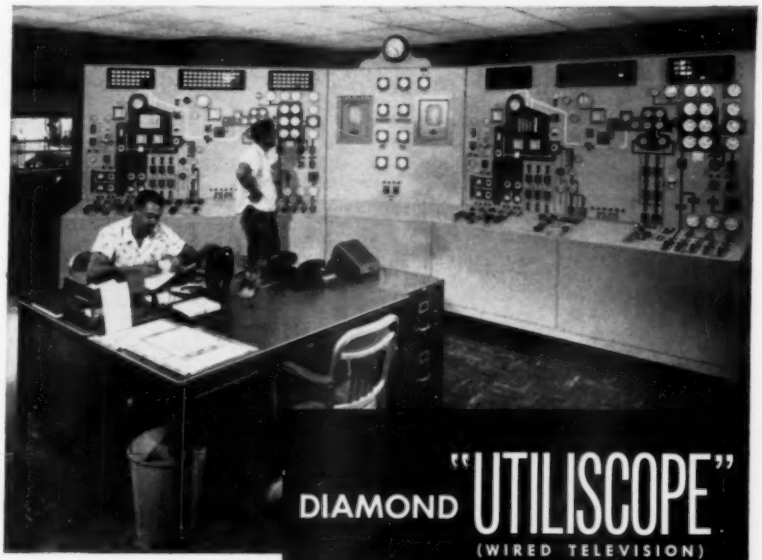
259 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

260 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

261 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

262 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler

AUTOMATION IN POWER PLANTS



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feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

263 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, and explains operation. The Reliance Gauge Column Co.

264 Remote Reading Gages — Eight-pp Catalog 291, revised, shows new designs in remote reading liquid level gages, including the Red Flasher Truscale. This has a scale which flashes continuously in red for a positive warning when boiler water level gets too high or too low. Profusely illustrated with photos and engineering drawings, catalog covers gages in four pressure groups from under 900 to over 1500 psi. Jerguson Gage & Valve Co.

265 Bi-Color Gage — Bulletin 1174 gives advantages of company's Multi-Port bi-color gage made for boiler operating pressures to 3000 psi. Points out chief design features, illustrates construction details through photos and drawings. Diamond Power Specialty Corp.

266 Pressure Regulators — Form 1011, on flow regulators, provides selection data with photos on three principal types of main valves and pilots. Also illustrated by line drawings are three suggested applications of regulators. A steam capacity table for the selection of main valve size is also shown. Spence Engineering Co., Inc.

267 Ideas on Push Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

LUBRICATION

268 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures are discussed. Sinclair Refining Co.

Postage-free cards for ordering catalogs are on page 128. You may also use the cards to order literature mentioned in the ads.

270 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

271 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp arti-

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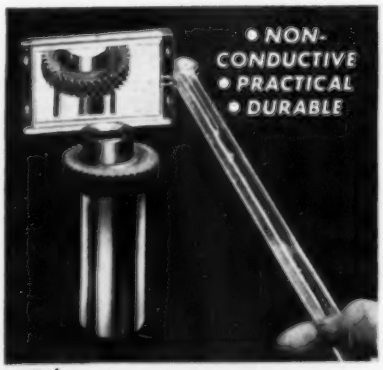

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cle on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved, in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

REFRACTORIES, INSULATIONS

272 Refractory Castable — Bulletin R-40 describes use of Kaocrete-32, a high temperature refractory castable, in boiler ashpits. A discussion of various methods of ash removal, along with maintenance problems peculiar to each, is presented. Four typical installations are detailed. Refractories Div., The Babcock & Wilcox Co.

273 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from −400 F to 3000 F. Johns-Manville.

274 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

275 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

276 Duct Insulation — Engineering data and application instructions for company's semi-rigid, spun mineral wool duct insulation are presented in this informative bulletin. Thermal and sound absorption characteristics are presented in tabular form and physical, chemical, mechanical properties given. Baldwin-Hill Co.

277 Underground Pipe Insulation — This illustrated bulletin discusses the problems of underground pipe insulation and explains how company's insulation for hot underground pipes overcomes them. On-the-job photos illustrate ease of application; brief technical data are also included. American Gilsonite Co.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

278 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based on the "J" factor.

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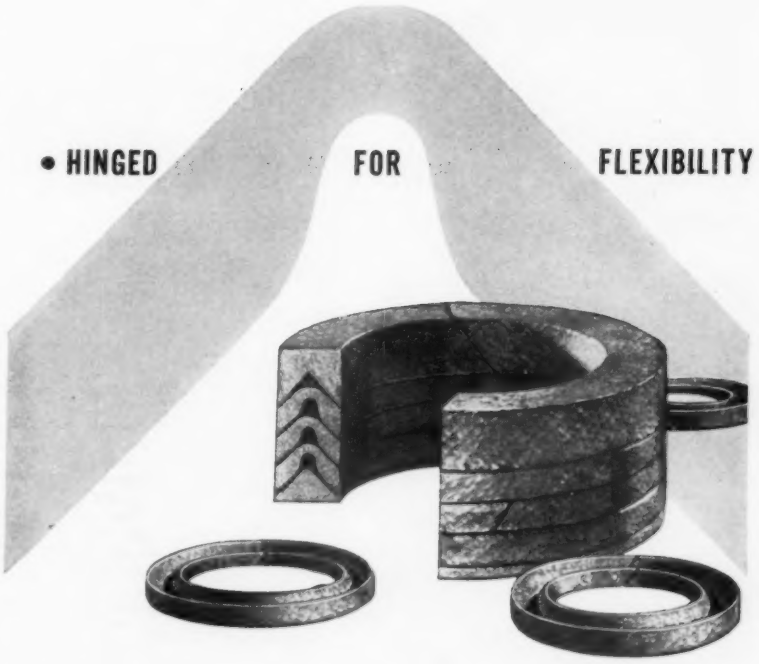

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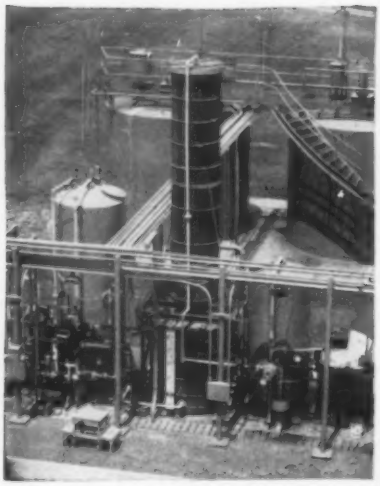

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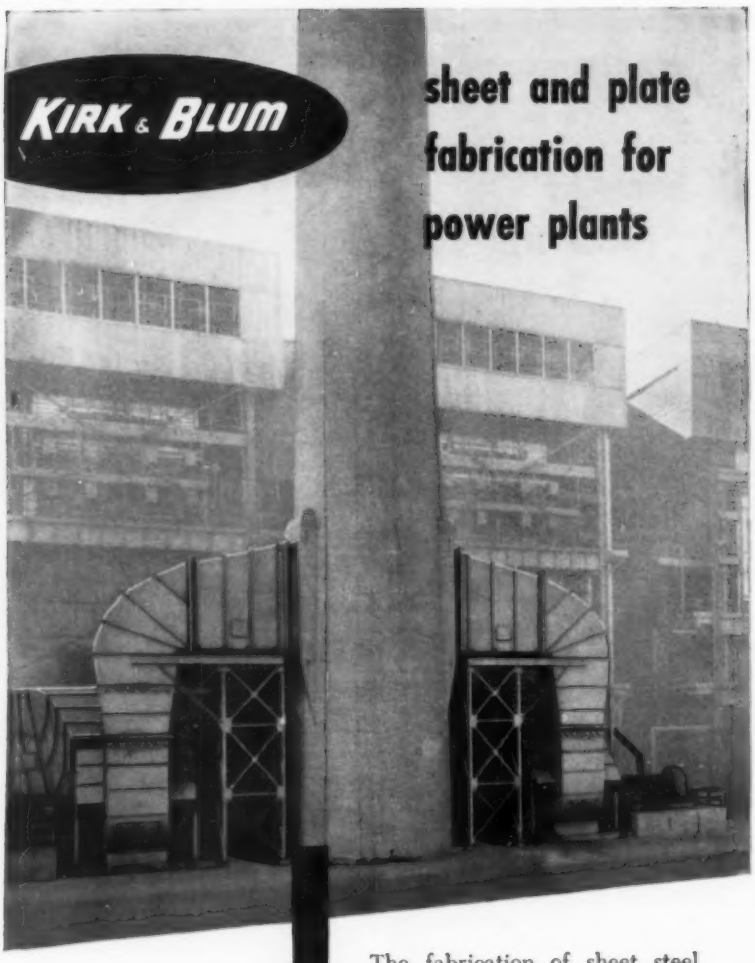

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This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, valves and fittings. Charts and tables list physical and thermal characteristics. Union Asbestos & Rubber Co.

CORROSION CONTROL

279 Corrosion Control. — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition, cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

280 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

281 Guide to Corrosion Prevention — How Bitumastic protective coatings aid in fight against corrosion is told in this 12-pp booklet. Discusses corrosion as a universal industrial problem, role of protective coatings in cutting costs and lengthening service life of structures and equipment, and gives data on several coal tar-based coatings intended to solve a variety of corrosion problems. Twelve typical case histories covering use of these coatings in varied industries described. Koppers Co., Inc.

OTHER EQUIPMENT

283 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

284 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

286 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

288 Ejector Data — This 12-pp bulletin presents company's steam jet air ejectors designed for efficient, low cost air removal from condensers. Illustrates basic ejector assembly, and discusses principle of operation. Single- and multi-stage units are shown. Also described are steam jets for special services and air ejector acces-

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sories. Engineering data pertinent to ejector application in power plants, process plants and evaporators included. Condenser Service and Engineering Co., Inc.

289 Metal Laminates — Types of metal laminates, metals which can be laminated, and use in heat exchangers, electronics and other applications are detailed in this illustrated 8-pp bulletin. Advantages and properties are described, and size data given. Bridgeport Brass Co.

291 Engineering For Atomic Power — How $400 million in coin silver weighing 14,000 tons were borrowed from the U. S. Treasurer for use as electrical conductors at the atomic energy plant in Oak Ridge, during the war when copper was scarce, is told in this 36-pp illustrated booklet. Describes the firm's role in the development of atomic energy and outlines its activities in peacetime applications. Stone & Webster Engineering Corp.

292 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

293 Refrigeration Condensers — Engineering data on a complete range of sizes and types of refrigeration condensers are featured in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers. Selection data, dimensions, dimensional diagrams and tables of pipe sizes given. Henry Vogt Machine Co.

290 On Coal Burning Plants — Presented in this illustrated 20-pp booklet, "More and more firms are burning coal the modern way . . ." are eight case histories of notable coal burning plants. They include industrial, commercial and institution power plants, both modernization and new construction. Economy and other advantages of coal as a fuel are stressed. Bituminous Coal Institute.

297 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data rating tables, performance charts. Buffalo Forge Co.

299 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

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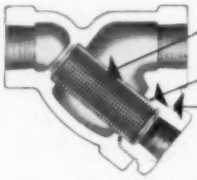

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Are You Up-to-Date on Coal?

Here are notes from a recent parley

PROBLEMS OF COAL as used in power stations came in for close scrutiny at the most recent Joint Solid Fuels Conference, held in Quebec City under the sponsorship of the Canadian Institute of Mining and Metallurgy, the American Society of Mechanical Engineers, and the American Institute of Mining, Metallurgical and Petroleum Engineers.

What About Storage Bins?

Two engineers who criticized the design of present coal storage bins as based on rule-of-thumb methods, reported on a new invention to remedy fuel-flow problems.

F. D. Cooper and J. R. Garvey of Bituminous Coal Research said they had found experimentally that poor flow performance of conventional storage bins is due to a central core movement responsible for "rat holes" and high pressures on coal which cause its adhesion to the hopper walls.

Experiments showed that the solution would be a cheap means to eliminate the central core and provide an environment of low, steady pressures on the hopper walls. They achieved this by using a 75-deg sloped hopper and an inverted cone of stainless steel. In experiments this allowed the handling of ¼-in. coal containing 15 per cent moisture in a steady, reliable stream. Coal with up to 28 per cent moisture could be handled with the use of a vibrator.

Cooper and Garvey reported that they had not yet fully explored the possibilities of the development and planned to continue work on it.

Influence of St. Lawrence Seaway

J. R. Frith, president of the Lake Coal Division of the M. A. Hanna Company of Cleveland, outlined results he expects the St. Lawrence Seaway to have on coal shipping. One is lowered prices of U. S. coal shipped up the St. Lawrence.

In spite of potential lowered costs, Frith noted that eastbound coal shipments would probably drop considerably soon after the opening of the Seaway, due to the expected availability of natural gas in the Montreal area. However, he predicted a tremendous industrial growth of both U. S. and Canadian firms on the St. Lawrence between Lake Ontario and Montreal, and that within a few years after completion of the Seaway, the coal requirements of new industry, together with requirements of the thermal power plants which will have to be built to supply the increased power, would involve the consumption of several million tons of additional coal.

Frith pointed out another possibility which he felt would dwarf local movement — northern export of U. S. coal to Europe. Instead of present overseas routes going through East Coast ports at Hampton Roads, Baltimore and Philadelphia, southern coal could move to Lake Erie much more inexpensively, and then to Europe.

Frith indicated that an alternate aid to overseas shipping might come from the establishment of a transfer dock east of Montreal. Lake boats on their way down for ore could carry coal to the transfer dock to be loaded into ocean vessels, shortening the trip to Europe by 500 to 800 miles.

Getting the Best Buy

Edwin D. Holdup, station superintendent of the Ontario Hydro-Electric Power Commission of Toronto, said that there are at least 13 characteristics of coal that must be considered before an engineer can be sure he is getting the best buy for his generating station. In addition to such fundamental items as the amount of heat that can be obtained from each ton, he must consider the amount of sulphur, which may form corrosive acids when the coal is burned, and the amount of other noxious gases that may be formed to contribute to air pollution.

pd

"Why Not Play Safe And Buy Your STACK As You Buy Your Car?"

"Joe, you wouldn't buy the engine of your car from one manufacturer, the wheels from another and the body from still another, would you? Neither would I. And when I design for induced draft, I specify a P-D Stack because the I.D. Fan, though it is important, isn't the whole story. The combined breeching, stack and fan, built as ONE apparatus, gives me unit responsibility, compact design, simplified engineering, and positive performance, with a lot less purchasing details.

"Another thing, I'd rather buy my Dust Collector from the same manufacturer that made my Stack and Fan. For this is all part of the same system for handling the gas after it leaves my boiler unit.

"There's nothing like putting all the responsibility on ONE manufacturer's shoulders if you can, for then you'll come out on the long end nine times out of ten. Buying such equipment piece-meal is antiquated and costly."

You can save a lot of time, trouble and money by purchasing your Stack and Dust Collector from Prat-Daniel.

Write for data.

Project Engineers

THE THERMIX CORPORATION

P. O. Box 1189-2, GREENWICH, CONN.

(Offices in 38 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

Designers and Manufacturers

PRAT-DANIEL CORPORATION

SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

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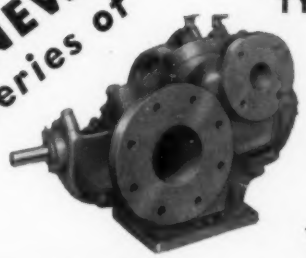
here's an ANGLE 45° that generously PAYS OFF

A NEW series of **AURORA®** TYPE A



two stage diagonally split case centrifugal

MULTI-PURPOSE PUMPS

You will find that the diagonally split case offers substantial new advantages while retaining all of the best features of the horizontally split case pumps — in that the entire rotating element can be removed without disturbing piping — or — disturbing the pump-motor-base alignment. CONSIDER —

these PLUS BENEFITS

Suited to many applications, importantly BOILER FEED SERVICE as well as hot or volatile liquids duties.

•

Low NPSH Characteristics

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Being self-venting they WILL NOT VAPOR LOCK

•

45° split allows both suction and discharge to be in the bottom half of casing but above the center line of the pump.

Aurora Type AJ Centrifugal Pump with Water Cooled Bearings and Stuffing Boxes

STANDARD

These 45° diagonally split case pumps have, as standard, 125# A.S.A. Suction Flange and 250# A.S.A. Discharge Flange. Type AJ Pumps are usually Bronze-Fitted but can be furnished All-Iron or Stainless Steel trim for high temperature conditions.

WRITE FOR BULLETIN 106DS

Your Inquiries Will Receive Prompt Attention
DISTRIBUTORS IN PRINCIPAL CITIES

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

40 DEARBORN ST. • AURORA • ILLINOIS
EXPORT DEPARTMENT — Aurora, Illinois — Cable Address "NYABINT"

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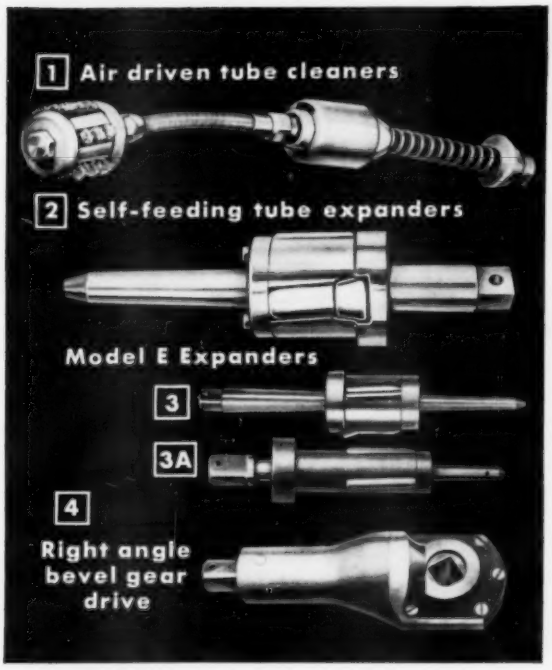
Keep boilers on the line with

WILSON TUBE MAINTENANCE TOOLS



1 Heavy-duty air driven tube cleaners are designed to deliver maximum power at the most efficient cutter head speeds while negotiating sharp bends, the Model ECT Air Cleaners are excellent for cleaning curved boiler tubes from 2½" to 4½" O.D.

2 Wilson Model 38 tube expanders are self-feeding and parallel expanding. They are of the single flare roll type. Available for tubes 1" O.D. to 4½" O.D. with various roll lengths for tube seats ¾" and up.

3 Flaring type expander 1" O.D. to 4½" O.D. tubes, ½" to 2" tube seats.

3A Long reach type expander 1" O.D. to 4½" O.D. tubes, 2½" to 5" tube seats.

4 This Wilson bevel gear drive is expressly manufactured to meet continuous and heavy duty service conditions. The one piece all steel body is extremely rigid and not subject to distortion. The maintenance of perfect gear alignment is assured with consequent long service life.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88. TW-882

Representatives in principal cities
THOMAS C. WILSON, INC.
21-11 44th Ave., Long Island City 1, N. Y.
Cable address: "Tubeclean", New York

WILSON
TUBE CLEANERS • TUBE EXPANDERS

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Stonega Coke and Coal Company

GLENBROOK — RODA — CROSSBROOK

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Old King Mining Company
No. 1 & No. 2
ASHLO SUNFIRE OLD KING HARDBURLY

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PREMIUM ANTHRACITE
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General Coal Company

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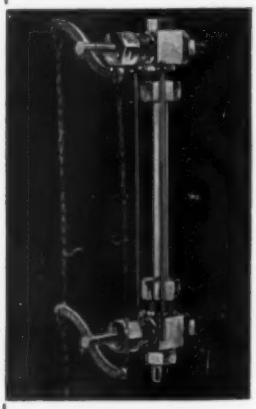
PBH Water Gauges

QUICK CLOSING—Gauges opened or shut with one quarter turn providing quick shut-off of danger and expense.



STEAM PROOF AND LEAK-TIGHT. Extra deep stuffing box nuts with ample size high quality composition packing.

MEET A. S. M. E. CODE. Valves are made of A.S.M.E. bronze stamped with maximum working pressure. Operating chain handles furnished complying with Code requirements.

All valves rigidly tested and inspected before shipment.

Send for a copy of Catalog A-51

●

Our 61st Year

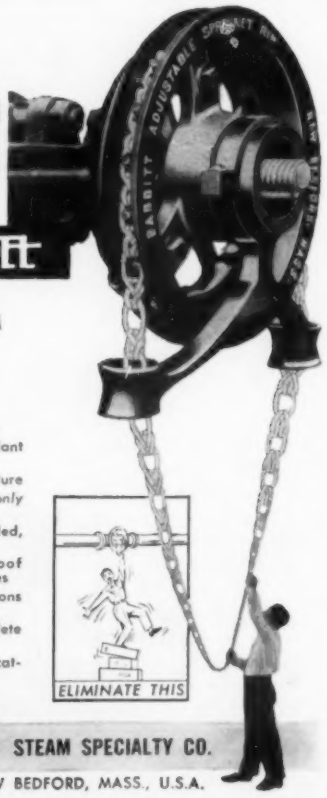
THE PAUL B. HUYETTE CO., INC.
401 NORTH BROAD STREET PHILADELPHIA 8, PA.

For more data circle 590 on Post Card

11-8

SAFE, Floor Level OPERATION *with a* Babbitt

Adjustable
SPROCKET RIM
with Chain Guide



- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance, first cost only cost
- Packed, completely assembled, one to a carton
- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
- Write for new descriptive catalog sheet and prices

Babbitt STEAM SPECIALTY CO.
4 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

For more data circle 591 on Post Card

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.
2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.
3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.
4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.
5. Sleeves carried on bearing rings, located on transverse center line of hub spline faces (the load-carrying surfaces) . . . no crank action, no vibration.
6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3702 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
Engineered Products Sold with Service.

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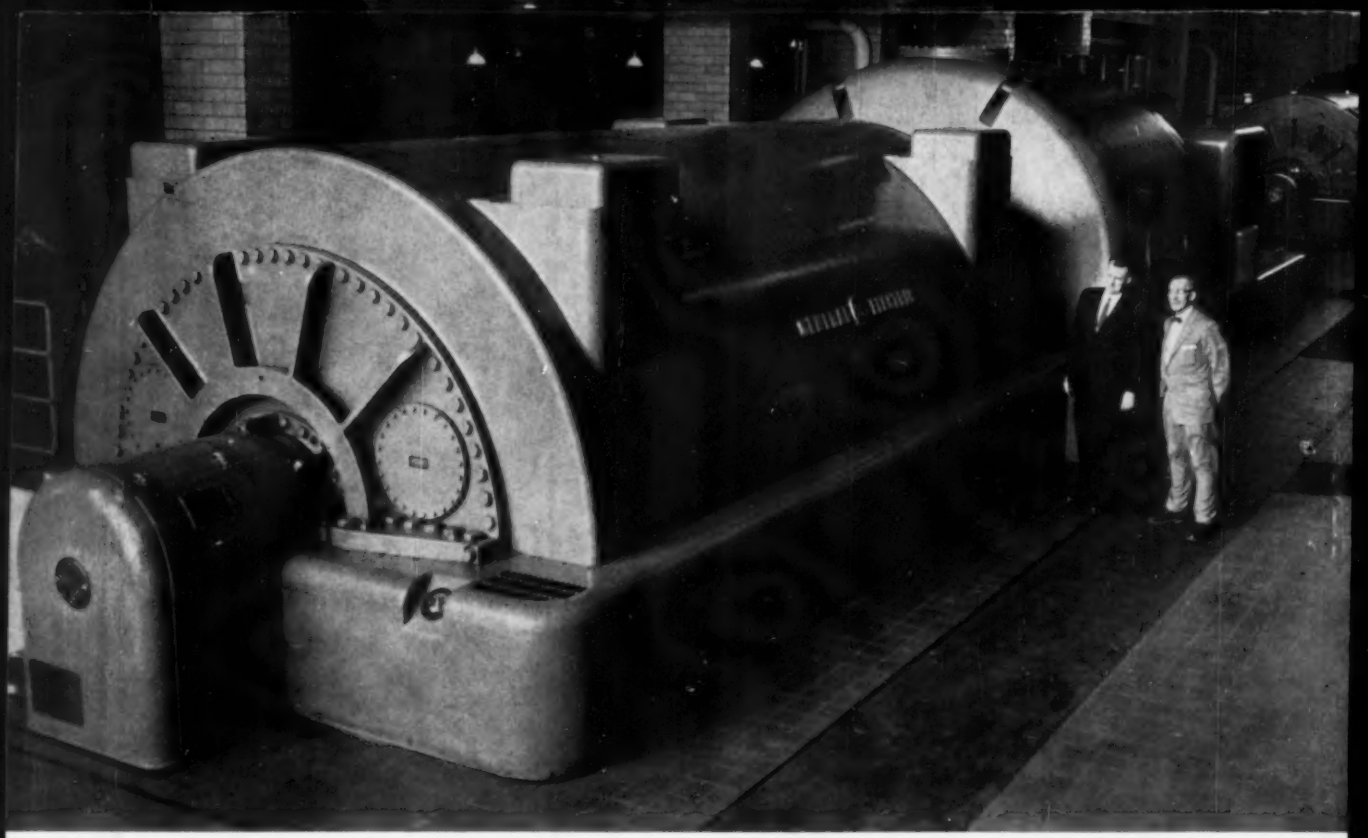

This new 70,000 kw reheat turbine—like all other turbines in this plant—is 100% Texaco-lubricated to keep it free from rust, sludge and foam.

A large Eastern Utility found:

Texaco gives these 3 big benefits for complete turbine protection:

1. Unquestionable dependability. Texaco Regal Oil R&O keeps the utility's turbine system clean; prevents rust, sludge and foam from forming; keeps bearing temperature normal and governor response instantaneous. Texaco dependability is a *fact* for this utility, based on long experience.

2. High efficiency. Texaco Regal Oil R&O assures smooth performance and freedom from unscheduled outages. Texaco Regal Oil R&O gives bearings full protection throughout an extra-long oil service life.

3. Technical service. Texaco offers this important benefit at a time when power demands are almost out-growing turbine production. Past experience in the power plants has proved Texaco Lubrication Engineering Service to be quick and reliable. This service is always available to Texaco customers—whatever the need.

There is a complete line of Texaco Regal Oils R&O to meet the requirements of all leading turbine manufacturers, regardless of turbine type or size. Let a Texaco lubrication expert help you select the Texaco Regal Oil R&O that will keep turbine efficiency high and maintenance costs at a minimum. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States—or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.

TUNE IN . . . Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

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